THE THRESHER'S GUIDE

VOL. II.

PUBLISHED BY
THE AMERICAN THRESHERMAN
MADISON, WISCONSIN

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BEING A REPRINT FROM THE THRESHER'S
SCHOOL OF MODERN METHODS OF
THE AMERICAN THRESHERMAN

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MADISON, WISCONSIN

FOREWORD

Three years ago we promised to publish a book on grain separators and this book is the fulfillment of that promise.

Volume I was devoted entirely to the steam traction engine; while this volume treats only of the separator and the business side of threshing and plowing. Each volume is complete in itself and no reference is made from one to the other. Because a person does not happen to have Volume I is no reason why he should not possess Volume II.

Chapter I on factors entering into the cost of doing work is entirely original. For Chapter II on the early history of theshing we are indebted mainly to Audrey. All the remaining chapters were compiled from original sources and are the result of much correspondence and investigation.

We do not claim that the historical sections are complete and we are well aware that many who contributed to the art have not even been mentioned. The only printed records of much of the history of the threshing machine and its various parts can be found only in the Patent Office in Washington, D. C., and in various court records. The inventors as a rule did not publish the record of their investigations. There is no little difficulty, therefore, involved in gathering information that can be relied upon.

The practical suggestions found scattered through the book, it is believed, cover the operation of threshing machines more fully than any other book on the subject.

We shall feel gratified if this volume receives as kindly a welcome as Volume I.

PHILIP S. ROSE.

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THE THRESHER'S GUIDE

VOL. II

CHAPTER I.

FACTORS ENTERING INTO COST OF THRESHING AND OTHER WORK.

THE BUSINESS OF THRESHING.

Many men assume that they are fitted to be threshermen because they like to run a traction engine or tend a separator. Right here is where they are pretty liable to make a mistake. There is just as much sense in thinking you have a call to thresh merely because you love to see the wheels "go round" as there is to think you have a call to preach because you love yellow-legged chicken. These things may be valuable qualifications in either profession but they are not necessarily winners.

Love for one's profession is a mighty fine thing, but my experience indicates that it grows cold or waxes hot pretty much in proportion to what it brings us in good hard American dollars. The thresherman who can not pay his notes when they come due is not generally a very amiable, enthusiastic sort of fellow, even if he can do circus stunts with his engine.

It is not my purpose to belittle the mechanical end of the business, because that is mighty important, but the financial end is after all the most important consideration. No man has any right, in justice to himself, to buy a threshing outfit until he has carefully considered the business end of the proposition and decided upon his own business capacity. Threshing at best is a hazardous business. The investment is heavy, the profits never very large, and the risks are enormous. Under favorable conditions and in the hands of right men, the business can be made to pay. Many men do make it pay, but, on the other hand, there are many failures. In fact, there are too many failures.

The responsibility for these failures, in most cases, rests with the men who engage in the business. They do not analyze conditions carefully enough. They do not consider the facts that every business man must consider before engaging in a new enterprise. Apparently a great many bank on their luck when the facts are against them.

It has been well said that "facts are stubborn things." You may ignore them today and apparently escape from them, but they will rise up and smite you tomorrow, when escape is impossible. Right here I wish to quote from Mr. John D. Rockefeller's "Reminiscences of Men and Events." He says: "Good old-fashioned common sense has always been a mighty rare commodity. When a man's affairs are not going very well, he hates to study the books and face the truth. From the first, the men who managed the Standard Oil Company kept their books intelligently as well as correctly. We knew how much we made and where we gained or lost. At least, we tried not to deceive ourselves.

"My ideas of business are no doubt old-fashioned, but the fundamental principles do not change from generation to generation, and sometimes I think that our quick-witted American business men, whose spirit and energy are so splendid, do not always sufficiently study the real underlying foundations of business management. I have spoken of the necessity of being frank and honest with one's self about one's own affairs. Many people assume that they can get away from the truth by avoiding thinking about it, but the natural law is inevitable, and the sooner it is recognized the better."

That is good straight talk from a man who knows and it applies just as surely to the business of threshing as to any other business. To analyze conditions, tabulate the facts and face the truth even if it hurts; that is what makes for business success, but it requires an uncommon stock of common sense and some bravery to do it.

There is a certain amount of preliminary study necessary before a man thinks seriously of engaging in the threshing business, and it is my purpose to discuss somewhat in detail the various factors that enter into the final solution of the problem.

I have already pointed out that the man must first study himself carefully, impartially, and honestly. He must take the facts as they actually are. This is probably the hardest task a man can do because personal vanity always rises up to blind our eyes to the truth. This question of personal fitness, however, must be settled and no one can do it but the individual who has the problem to solve. In arriving at the answer I should consider first my business ability; second, my energy and aggressiveness; third, my standing in the community; and fourth, my experience or technical knowledge. I have put technical knowledge last because it is always possible to hire some one to make up this deficiency, but the other three qualities can neither be hired nor bought. It is true one can sometimes find a partner to make up a deficiency in one of the first three essentials, but even this is apt to prove a source of trouble.

Business ability is not easy to define. It includes many things, among which may be mentioned handling men, keeping accounts, laying out the season's run, making contracts, collecting, and keeping the rig in the best of order and everyone good natured. Handling men, and I mean by this the customers as well as the crew, is mainly a matter of leadership. It is something that can be learned partially, but it is more a matter of natural aptitude. Some men are born leaders and others are not. There always have been "hewers of wood and drawers of water," and always will be. If you find out you are one of this class and are bound to thresh anyway, get a job hauling water or pitching bundles. It will prove more satisfactory in the end. It is best to face this matter squarely and don't argue because John Doe or Ole Olson has a rig that you must have one too. There is no logic in that.

We will leave the matter of cost, keeping, etc., for subsequent discussion and take up the second consideration, that of energy and aggressiveness. This is something an honest man can settle in short order. No one knows better than himself if he is a hustler and can stand the strain of long hours of hard work. This is essential to success in threshing more than in most businesses because the season is short and only hustlers can win. And another thing, a man must be of the temperament to fight hard when luck is against him. For if he gets discouraged and "lies down" when difficulties arise, as they surely will, he can't win.

The third point is also easily disposed of. A man generally knows whether his prospective customers are friendly toward him or not. If they are it is a mighty big business asset. If they are not, it is a serious handicap, because no matter how well he does his work they will get some one else if it is just as convenient. It pays to have customers who will wait until you can get to them and if need be let your competitor pull by. This is a pretty serious test of friendship sometimes, but when a man can command that sort of loyalty it means success. It is what is called in business generally good-will. When a firm sells out it sells its good-will, when a doctor sells his practice he sells his good-will. In his case it is all there is to sell and yet it often commands a pretty big price. Good-will, or one's standing in the community, is after all a pretty valuable asset and the man who thinks of going into business can not afford to overlook it or fail to protect it, once it is gained, or to overlook the extent to which his competitor has acquired the good-will of the public.

The matter of technical skill or experience must not be lost sight of. In fact, it has been the purpose of these lessons to advise our readers along these lines. It is important, and no business of a

mechanical nature can hope to succeed unless they are competent men to operate and care for the machinery. It is desirable that the owner of the outfit have this skill. It saves money and delays and adds to the success of the business provided the other end, the business end, is handled as it should be. In any event, the owner or manager should know enough to know whether the men he hires are competent and do their work well. This amount of technical knowledge is imperative. Beyond that, men of special training can always be hired for a sufficient consideration. And right here I want to say emphatically, that a cheap, incompetent man is the dearest man you can employ to care for expensive machinery. The good business owner will see to it that he secures really competent help, even if he does have to pay pretty high wages.

There are a good many points to be considered before a man finally decides to buy a threshing outfit. We will assume to begin with that the points heretofore brought out have been settled and all that is now necessary to consider is the business or money side of the proposition.

No man of sense cares to engage in a business unless there are at least fair prospects for making a profit. And if he has the qualifications that make for success he will go over the situation carefully and figure out with actual figures every item that enters into the problem. Then after he has checked his figures carefully in every way and has made due allowances for the usual risks, he is justified in going ahead, provided the figures show a good margin of profit.

If every man who buys a rig would first figure carefully his chances for success, it is quite likely that fewer threshing rigs would be bought. On the other hand, it is equally certain that there would be fewer bad sales and the business would be in better shape both from the manufacturer's and the operator's standpoint.

No man should allow a salesman to do his figuring for him. A clever salesman can make any proposition look attractive even when the actual facts are against him. His business is to sell. That is what he is paid for, and if he doesn't he knows he will lose his job. His figures and his arguments may be and often are perfectly accurate, but often they are purposely misleading, or if they are not purposely misleading, the facts are very rarely carefully gathered and analyzed. It is the duty of the prospective buyer to do his own figuring before he says a word to anybody about buying a rig.

There are a good many men who are talked into buying. They haven't any intention of buying to begin with and know they shouldn't, but they allow themselves to be "worked." Right here I want to say emphatically that a man who allows himself to be

"worked" in this way is a pretty poor sort of a man. I once knew a man of this sort who gave a salesman an order to get rid of him. When he went home he told his wife what he had done. She didn't approve of his action and asked him to cancel the order at once. He objected and she, being a big, strapping woman, wasted mighty few words, but took a piece of tug that happened to be handy and gave him a sound thrashing. That rig was never delivered and it is a safe bet no salesman would have "worked" her for an order. I have often thought it might be a good thing for the threshing business if there were more wives that had her ability.

Now I do not mean to cast any reflections on threshermen generally. They are on the whole keen, competent men, but there are some who are not. There are some who have been coaxed and flattered and almost forced into buying by a clever salesman. They have listened to a smooth talker when they knew they had no business to even consider the proposition and have ended by giving an order. They dallied with temptation and were lost. Such men really deserve our sympathy.

The only safe course for anyone to pursue in business matters is the one I pointed out in the beginning, that is, first figure out the possibilities before talking with any salesman. After you have decided, let it be known as widely as possible that you are in the market and then don't be in too big a hurry to place an order. You may save a nice little sum by waiting a while before doing so. And above all, don't allow anyone to talk you into buying until you have definitely decided after carefully considering the merits of the case.

Let us now proceed to consider the principal factors that a thresherman should consider before buying a rig. The first one that presents itself to a careful business man is the amount of business in sight which he can be reasonably sure of getting. The best way to get at this is to figure out how many acres of wheat, oats, barley, flax, etc., he is reasonably sure of. Then estimate the number of bushels of each kind of grain that will probably be produced per acre and thus get at the total number of bushels of each kind of grain that he will probably have to thresh. The average yield of grain per acre as computed by the commissioner of agriculture of the state should be taken in estimating the yield per acre. This number may and will probably appear low, but taking one year with another, it will be found a pretty accurate average.

The next thing to consider is the price paid per bushel for threshing each of the different kinds of grain. From these figures it is easy to compute the average gross earnings of the outfit. In some localities there is other work that the engine may be put to during all or a

part of the rest of the year, such as plowing, shredding, sawing, grading, etc. The amount of this work should also be estimated and the probable gross earnings from all these other sources added to the earnings made in threshing. This will give the total gross earnings.

The next thing to consider is the matter of expenses and here is where some careful figuring or estimating should be done.

In looking over the territory, one should consider the size of the jobs, the probable number of settings, and the distance that must be traveled from one job to the other on an average. In order to get at this matter of distance one should lay out his territory as carefully as possible and decide upon the route to take from one job to the other. In this way it will be possible to get to all the jobs during the season's run with the least time spent on the road. There are sure to be many times when it is impossible to follow out a definite program of this kind because there are often certain good customers who can not wait beyond a certain time for a machine. In a case of this kind it may be necessary to change the line of travel for the sake of accommodation, or to keep out a rival. In any case, however, the good business man will figure the added cost of moving and if it is too great a sacrifice, point it out to the customer and refuse. In estimating the cost of setting and of moving, one must consider the time spent, the wages paid to labor, and the wear and tear on machinery. If possible, and I believe it is, the thresherman should figure the cost per mile for moving and the cost for setting and make these items a part of the fixed charges just the same as wages, fuel, etc.

The next important item is that of wages. If a full crew is used, an estimate should be made of the total daily wages and the cost of boarding the crew per day. The owner should figure his own wages higher by a dollar or two a day than that of any of his men, and these wages should under no circumstances be considered a part of the *profits.*

The next items of expense are those of fuel, oil and repairs. These must be estimated since it is impossible to get at all of them with absolute certainty. Fuel and oil can be estimated fairly close but repairs can not be. The best way to do in a case of this kind is to make an allowance that will be sure to amply cover all expenses of this nature, and if the estimate is too high the difference will appear at the end of the season as an item of profit.

Generally a ton of coal for a 20-horse power engine and a dollar a day for oil will cover the first two items. The matter of repairs should be figured at say two dollars per day for actual running time. The first year or two this estimate may be too high for a new rig, but after that it may run somewhat lower.

Then interest on the investment should be figured at the ruling rate of interest in the community where the rig is located. If the outfit costs $3,000 and the rate of interest is eight per cent, there must be $240 placed in the column of fixed charges. Depreciation must also be figured. If the outfit can be made to last ten years, the depreciation per year will amount to $300, and this sum must be added to the fixed charges. This item of depreciation is the sum which is set aside, as it were, to pay for the rig.

After all the items of profit are made up and all the items of expense, the difference will represent the total net profit.

At the end of each season, whether it be the plowing season, threshing season, or shredding season, the total expenses and the total profits should be figured. Then at the end of the year an estimate should be made of the actual running expenses per day for each kind of work. In doing this, interest and depreciation should be spread over the actual running time. In this way it will be possible to estimate with greater exactness just how much work must be done each day at whatever kind of work in order to meet current expenses and pay a fair profit.

In order to give a concrete meaning to some of the points previously discussed, let us assume an example and figure out the various items of expense connected with the operation of a threshing rig and, if possible, arrive at what should be a reasonable price to charge for threshing. It must be borne in mind that the values which I shall assume are liable to error in different sections of the country, but the general treatment of the subject will be the same for all sections. All that need be done to make the results fit the local conditions is to insert the proper values for labor, interest, etc., that obtain in the given locality.

We will assume that a thresherman, located, say in western North Dakota, bought an outfit consisting of a 30-horse power engine, a 40x66 separator, with self feeder, weigher, wind stacker, and main drive belt. Besides this he purchased two tank pumps, two water tanks and a cook car. The total cost of the outfit, after paying freight and equipping the cook car, amounted to $4,000. He had $400 to begin with and gave four notes of $900 each for the balance. The first note was made payable October first, after delivery, and the other three notes ran one, two and three years respectively, falling due on October first of each year. Interest was charged at the rate of eight per cent per annum. The rig was delivered on August first and settlement was made on that date.

The average life of a threshing outfit may be figured at eight years. The engine may last a little longer, but the separator will probably not last quite so long; so that an estimate of eight years is fairly liberal and actually a little more than the average for the section of the country where this thresherman lives and where farm machinery does not always receive the best of care.

The average number of days of actual threshing will be about twenty-four. In some places it runs as high as thirty days, and in other localities eighteen or twenty days will complete the season's run.

Following the custom of the country, the thresherman will furnish a complete crew, as follows, and pay the scale of wages set forth below:

1	Engineer	$5.00	per day
1	Fireman	3.00	" "
1	Separator man	5.00	" "
1	Water boy with team	5.00	" "
6	Bundle teams with drivers	30.00	" "
4	Spike pitchers	10.00	" "
4	Loaders	10.00	" "
1	Cook	4.00	" "
1	Manager	6.00	" "
20	Men Total wages	$78.00	per day

The cost of board for the men will not be less than fifty cents per day, making an additional charge of ten dollars per day. The wages of the crew do not have to be paid in wet weather when they can not work, but board must be furnished regardless of the weather, and it is an item of considerable importance in wet seasons.

We have heretofore suggested that two dollars per day should be charged to repairs. It is doubtful if this is figured high enough. With good luck the first year, repair bills will be light, but after that they will get larger each year until the rig is worn out. In regions where alkali is found in large quantities in the feed water, it makes flue repairs heavy. A set of flues will last only about four or five years and a new set will cost about one hundred twenty-five dollars. It will thus be seen that two dollars per day is a low estimate for repairs.

Oil for engine and separator will cost about one dollar per day, and incidental expenses another dollar. These incidental expenses cover such items as tools, waste, packing, belting, repairs and small extras.

We are now ready to consider the total expenses and figure how much they amount to per day. They may be tabulated as follows:

Interest on $4,000 at eight per cent	$320.00
Depreciation per year for eight years	500.00
Total wages paid for 24 days at $78 per day	1,872.00
Total for board and crew for 24 days	240.00
Total for repairs, oil, incidentals	96.00
Total expense for 24 days	$3,028.00
Total expenses per day	126.16

The usual price for wheat threshing in this thresherman's part of the country is nine cents per bushel. In order to meet expenses, therefore, without making any profit for himself he must thresh on an average of 1,402 bushels per day. This average takes into account all delays, time on the road, and time consumed in setting. Working at this rate, the thresherman would come out exactly even at the end of eight years provided he had no bad weather and no bad luck, on an outfit such as I have described. However, he would have a good deal of trouble meeting his notes when they came due and would have to have an extension of time on all of them.

Let us now see exactly how much he must thresh each day in order to meet his notes when they come due, assuming, as before, that he runs twenty-four days each season and that running expenses are as before indicated.

The debt of $4,000 was assumed on August first and the first payment fell due October first, two months afterward. While it is true that $400 of this amount was paid in cash, it does not alter the fact that it was worth eight per cent, consequently we must charge eight per cent on the entire $4,000 for two months. Tabulating all expenses and adding $900, the amount of the first payment, we have:

Interest on $4,000 for two months at eight per cent	$53.33
Wages of crew and board for 24 days	2,112.00
Repairs, oil and incidentals	96.00
First note	900.00
Total	$3,161.33
Charges per day	131.72

The number of bushels that must be threshed to cover this daily charge on the basis of nine cents per bushel must be 1,464 bushels.

The next year and each succeeding year, until the machine is paid for, the account will stand as follows:

Interest on $4,000 at eight per cent for one year.........	$320.00
Wages and board for crew............................	2,112.00
Repairs, oils, incidentals..............................	96.00
Second note..	900.00
Total..	$3,428.00

Dividing this total by twenty-four, the number of days, shows that there must be charged to the daily expense account the sum of $142.83. Again dividing this sum by nine, we arrive at the figure 1,598, which represents the average number of bushels of wheat that must be threshed per day in order to meet all payments on the machine as they come due.

It may be asked why no charge is made in this case for depreciation. In order to answer this question it is necessary to state that the depreciation charge is a fixed yearly charge which is introduced to offset the original cost. If this is taken care of in four years, by means of four annual payments, no other depreciation charge need be considered. The item depreciation is what is set aside annually to pay for the machine.

Working on the basis above set forth, and with no bad luck, the thresherman would at the beginning of the fifth season have his rig paid for, but during that time would have made no money except the six dollars per day as wages for acting as manager. He would, however, have an outfit good for three years more work. If he could, during that time, average 1,598 bushels of wheat threshed, per day, twenty-four days per year, he would make a profit of $990 per year.

His total profit on the rig at the end of eight years would therefore be $2,700 plus the interest on $900 for three years at eight per cent, or $216, making a total profit of $2,916. This is the maximum he could make on the figures I have shown above. He could, however, realize probably $150 on his outfit at the end of this period as extras and scrap iron, making a total profit of $3,066. In case of bad luck it might be much less.

On the other hand, exceptional crops or good luck might make his profit larger by a considerable amount.

Figuring his profits on the yearly basis, we find that they amount to $383.33 per year. This represents a net profit of about nine and one-half per cent on the original investment.

In the case of accidents, bad weather or poor crops, all of which are certain to occur in any period of eight years, the net profits will be smaller.

It may be urged that an average of only 1,600 bushels per day is rather low for such an outfit and doubtless it is, yet the fact must not be lost sight of that averages are always low. Figured on the basis of the average wheat yield of North Dakota, it means that the wheat growing on about one hundred twenty acres must be threshed every day. Figured on this basis it looks like a pretty fair average after all.

I have reduced the expense account to a daily average for the reason that I believe it is the correct method for the thresherman to pursue. It allows him to check up with his machine measure each night and tell approximately how he stands. He is thus able to tell very closely from one day to another whether he is making money or losing it. Furthermore, it gives him a keener appreciation of the value of time. For example, suppose he wants to know how much he loses in the case of an hour's delay. He can tell in a moment. Take the last case where his daily expense account was $142.83. If he works fourteen hours per day, the hourly charge is $10.20. If he has to shut down fifteen minutes to lace a belt, it costs him $2.55,—rather expensive, isn't it? After he figures a few items like this, he will see to it that his separator man and engineer look things over and get everything in shape before the machine starts.

We have just figured out how much profit a man might reasonably expect under *average* conditions who owned and operated a large outfit such as is used in the Northwest. The threshing was restricted wholly to wheat in order to make easier figuring and because it was assumed that other kinds of grain were charged for at a proportionate rate, which, if true, would make the figures presented practically correct. In this discussion it was assumed that no other work was done besides threshing. However, most threshermen have some side issue that they can turn their attention to at other seasons of the year. This extra work may be grinding feed, shredding, sawing or plowing, depending upon the section of country in which the thresherman is located. Our thresherman in the Northwest will almost certainly engage in plowing and it will be interesting to see how he will come out financially in this venture.

In order to engage in this business he will find it necessary to invest in a plow frame and plows that will cost approximately $1,200.00.

We will assume that he does thirty days plowing per year and that he receives one dollar per acre for stubble plowing. His crew will consist of an engineer, a fireman, who also handles the plow, and a man and team to haul coal and water. Oil will cost him about a

dollar per day, repairs on an average about three dollars per day, and coal about twelve dollars per day. In threshing he uses straw, but when it comes to plowing he will find it necessary to use coal. His total daily expense account may now be tabulated as follows:

Engineer's wages	$4.00	per day
Fireman's wages	3.00	per day
Man and team	4.00	per day
Oil	1.00	per day
Repairs	3.00	per day
Coal	12.00	per day
Total	$27.00	

In addition to this he must charge interest and depreciation on his plows. If money is worth eight per cent, the interest on $1,200.00 will amount to $96.00 per year. If the plows last as long as the rest of the outfit, eight years, there must be charged $120.00 per year for depreciation. The sum of these two items amounts to $216.00. If we divide the sum by thirty, the number of days during which the outfit works, we obtain $7.20 as the daily charge for interest and depreciation. This added to the daily labor account shows a total daily expense account of $34.20. Assuming a dollar per acre for plowing we see that our friend will be obliged to average thirty-four and one-fifth acres every day to meet expenses and all over and above this amount will be profit.

In most business enterprises twenty per cent is considered legitimate profit on the capital invested. If we apply this rule to the case in hand we find that the profit should amount to $240 for the season or eight dollars per day for thirty days. This represents eight acres more per day, thus bringing the average acreage which must be plowed up to forty-two and one-fifth acres per day.

Now let us see if this is a possible average to maintain. Most plowing engines are geared to run at from two and one-fourth to two and one-half miles per hour. Counting the necessary stops, two miles per hour would be a good average of speed for the entire day. If the engine works twelve hours per day it would travel a total distance of twenty-four miles. This represents a distance of 126,720 feet. A fourteen-inch plow traveling this distance would turn one and one-sixth times 126,720, or 147,840 square feet. There are 43,560 square feet in an acre and a simple division shows that one plow bottom will turn about 3.4 acres per day. In order to turn forty-two and one-fifth acres it would be necessary to use a twelve-bottom gang and

to make a trifle more than twenty-four miles per day. In good sandy loam it is possible, if the fields are large, to draw the twelve-bottom plows and to make the average I have figured, but it will require hustling every minute of the time. As a matter of fact, forty-two and one-fifth acres is a high average. I have record of one case where sixty-seven acres of stubble were plowed in a single day, but this is a very exceptional performance. Taking one day with another, it is doubtful if an *average* of forty acres per day can be maintained for a period of thirty days. If it can not be, it is very clear that plowing can not be done profitably for one dollar per acre.

The objection may be raised that in this matter of plowing, no account was taken of the interest on the money invested in the engine. This may be an error or not depending upon how the matter is considered. It will be noticed that I assumed the rig to have been bought primarily for threshing and the interest and depreciation were charged to that account. The matter of plowing was considered afterwards and I figured the profits and performance on this "side issue" separately, on the basis of one dollar per acre. This price is quite evidently too low.

If plowing is to be considered in the beginning, before the rig is purchased, the matter of interest and deprecation on the engine might be divided between plowing and threshing. This is the correct method to pursue, since it divides the charge in the proper proportion and shows the owner exactly how much he should charge for each kind of work. If worked out on this basis it will show that the threshing may be done for a trifle less and that the plowing will cost more. This is the correct way to figure since it distributes the charges where they really belong and does not compel one part of the business to pay for the loss in another part. In other words, the owner will figure in such a way as to make all parts of the business pay a reasonable profit and be enabled to fix his charges accordingly.

To show how this method works out, let us figure the problem from the beginning, using the data we have obtained as a basis of computation. We will also figure a profit of twenty per cent on the investment as this is the profit the "Society of Equity" maintains a farmer should make.

We will assume that the engine and necessary accessories cost, when delivered in the field ready for work, $2,700. The separator and cook car amount to $1,300 and the plows to $1,200.

The engine works fifty-four days per year, the separator twenty-four days, and the plows thirty days.

Interest on $2,700 at 8 per cent	$216.00
Interest to be charged to each working day of engine	4.00
Interest on $1,300 at 8 per cent	114.00
Interest to be charged to each working day of separator	4.67
Interest on $1,200 at 8 per cent	96.00
Interest to be charged to each working day of plows	3.20
Depreciation of engine per year, one-eighth of $2,700	337.50
Depreciation of engine for each day at work	6.25
Depreciation of separator per year, one-eighth of $1,300	162.50
Depreciation of separator per day	6.77
Depreciation of plows, one-eighth of $1,200	150.00
Depreciation of plows per day	5.00

For each day's threshing our expense account will now be as follows:

Interest on engine at 8 per cent	$4.00
Interest of separator	4.67
Depreciation of engine	6.25
Depreciation of separator	6.77
Board for crew	10.00
Wages for crew	78.00
Repairs, oil, incidentals, etc	3.00
Total daily expenses	$112.69

If the business must pay twenty per cent profit per year, we find that the engine must pay a total profit of $540.00, or $10.00 per each working day. The separator must show a profit of $260.00, or $10.83 per day; thus the profit for each day's threshing should be $20.83. Adding this to $112.69 gives us a total of $133.52 that the rig must earn per day threshing. If wheat is threshed for nine cents per bushel, a day's work will consist of 1,843 bushels. If a lower average than this can be maintained the price of threshing may be reduced.

Our daily expense account for plowing will now have the following items, to-wit:

Labor, fuel, oil, repairs, etc	$27.00
Depreciation of engine	6.25
Interest on engine per day	4.00
Depreciation of plows	5.00
Interest on plows	3.20
Total daily charge	$45.45

Since the engine is supposed to pay a profit of $10.00 per day and the plows twenty per cent on their cost or $4.00 per day, we have $14.00 to add to the above, making $59.45 as the total daily earnings of the engine and plows in order to make their proportion of the total gain.

If forty acres per day be estimated as the average day's work it shows that the price of plowing should be about $1.50 per acre.

It may be urged by some readers that my figures are not strictly accurate, and that my estimates are misleading, but it must be remembered that these figures are based on a single locality, and furthermore that my aim and object in presenting them is to impress upon threshermen the necessity for making close estimates and if possible show how the estimates should be made.

The size of rig to buy is a problem requiring careful study. It is not an easy problem to solve because there are a number of factors to be considered and weighed before a correct decision can be made.

The factors to be considered are the kind of work the outfit has to do, the amount of work available, the condition of the labor market, and the character of the country in which the outfit operates. All of these things have a vital bearing on the question and must be well considered from every point of view before the outfit is purchased.

Taking these up in the order named, let us proceed to consider what particular bearing each has on the problem. If the outfit is to be used for threshing purposes only, the size of the engine of course will be determined by the size of the largest separator. An engine with much more than enough power to handle a separator easily will not do its work as economically as one that is working at or near its full capacity. It will require more fuel and water for the power delivered at the fly wheel and will require more power for self propulsion.

Since the largest sized separators are about 44x72, it follows that for threshing purposes all that is required is an engine large enough to handle such a rig at its full capacity in all kinds of grain. This will require an engine rated at about 30-horse power. More power than this would be a source of loss rather than of gain, as already pointed out.

This presupposes that the separator is fitted with blower, feeder, weigher, and all extras. The next size of separator smaller, those with 36-inch cylinders, will not require more than a 25-horse power engine, although this is as small as should be used. An engine working under a load heavier than it can handle easily is at a serious disadvantage and wears itself out quickly.

If plowing is to be done, or grading, or other heavy road work, in addition to threshing, the desirability of a more powerful engine must

be considered. The question here resolves itself clearly into one of first cost and additional earning capacity. In order to get at this in a concrete way let us consider one of the largest sized engines made, and compare it with one of the moderate sized engines. Several of the largest field locomotives now on the market weigh upwards of twenty tons and if bought for cash will cost about $4,000 delivered. Engines of this size are not usually rated in horse power but will develop upwards of 150-horse power at the fly wheel, while their smaller prototypes which will weigh fourteen or fifteen tons will actually develop about 90-horse power. The cost of the latter delivered in the field will be, if paid for in cash, not far from $2,700. The difference in price will be, therefore, about $1,300. Since the smaller engine is large enough for threshing purposes, this extra amount must be charged to plowing only, and must be paid for in plowing if the venture is to be financially successful. It is perfectly clear that all expense over and above what is necessary for threshing must be charged entirely to some other account, which in this case is plowing or grading or some similar work. In order to use comparative figures we will assume plowing is to be the work performed.

If we make the same assumptions in regard to the number of days' work that we did heretofore, namely, twenty-four days threshing and thirty days plowing, our daily expense account will be about as follows:

Interest on $2,700 at 8 per cent	$216.00
Interest to be charged to each working day of a threshing engine ($216÷54)	4.00
Interest on $1,300 at 8 per cent	114.00
Interest to be charged per day on extra cost of plowing engine ($114÷30). To be charged to plowing only	3.80
Depreciation per year on threshing engine ($2,700÷8)	337.50
Depreciation per day ($337.50÷54)	6.25
Extra depreciation on plowing engine ($1,300÷8)	162.50
Extra depreciation, charged to plowing only ($162.50÷30)	5.42
Extra fuel per day, coal at $8.00 per ton	4.00
Extra for repairs (estimated)	1.00
Extra profit at 20 per cent on $1,300	260.00
Extra profit per day ($260÷30). Plowing only	8.67
Total extra daily charges are—	
Large engine, over and above smaller engine	$22.89
Charges on smaller engine as per previously mentioned	59.45
Total daily charges on large engine	$82.34

At $1.50 per acre for plowing this would require a daily average of practically fifty-five acres per day. In order to increase the average to fifty-five acres it would be necessary to use at least one-third as many more plow bottoms or to turn sixteen instead of twelve furrows. The cost of plows and plow frames would also be greater than for the smaller rig, thus making it necessary to increase the average daily amount plowed to at least fifty-six acres per day. It is very doubtful even with a rig as large as the one we have considered if it is possible to maintain such a high average. In view of these figures it seems clear that an engine of the size specified would be unprofitable unless it could be made to work much more than thirty days per year in plowing. If the engine could be used sixty days per year, and maintain an average of fifty acres per day it would make money for its owner. Of course the charges for depreciation and repairs would be considerably greater but the fixed daily interest charges would be much less. It would be interesting to figure the problem on this basis, but enough has already been given to enable the reader to do this for himself. My object is to call forcibly to the reader's attention all the factors involved so that he may overlook none of them in making his own calculations.

In addition to the financial interest involved in using large engines, the matter of weight must be considered with reference to the character of the soil, the size of the bridges, etc.

An engine that is too heavy for travel over the soil without sinking in is too large, or an engine that is too large for the bridges over which it must pass is a poor investment. These are things that the purchaser must consider before buying.

Then there is the matter of labor and the amount of work available. Since an engine may last eight years, the future as well as the immediate present must be considered. If a man owns two or three sections of land, making enough land of his own to keep the engine busy, he can easily discount the future, but if he expects to do custom work and the farms are small, averaging from one-quarter to one-half a section, labor conditions may change in a few years so that there will not be enough work available to keep the engine busy. As the country fills up with people and horses it becomes more and more difficult to operate these large rigs at a profit.

Another thing that must be considered is the size of the fields that are to be plowed. Small fields are unprofitable on account of the lost time spent in turning. Where furrows a mile long can be turned it is much easier to maintain a high average of acres plowed per day than where the fields are smaller. This factor alone may be the de-

termining factor in all steam plowing and where very large engines are contemplated it is always an exceedingly important factor.

In concluding this discussion of large engines, it would seem to me that where the fields are large, labor is scarce and high priced, and especially where a man owns several sections of land there may be some profit in using very large engines. Conditions such as now exist in western Canada or in a few sections of the United States are particularly adapted to engines of this class, but in view of the rapid development of the country it is doubtful if very large engines are to be preferred to the medium sized machines.

Another interesting discussion and one that I may take up in the future relates to small threshing outfits for private use or for the use of one or two neighbors. The size of outfit to buy and the amount of grain to be threshed in order to make the venture profitable are points to be considered.

There are very few threshermen or farmers or men who make their living directly in some form of agriculture who keep a system of books. They never know exactly the condition of their business. They can not tell whether they are making or losing until all accounts are in and they count the cash left. They depend upon their memories, trust to luck and blunder along. They do not do business on business principles and often carry along a losing proposition, because they have never figured out just what they are doing. In fact, they have no certain sure data at hand to use as a basis for figuring and they can not have such data until they start a system of accounts.

The only way for one to study his business intelligently is to keep an exact account of all receipts and expenditures and make due allowance for all fixed charges, such as interest and depreciation. These two latter items are the ones on which most threshermen fall down.

I have just finished reading a large number of letters from men who do steam plowing in which they set forth their receipts and expenditures and state how much they are able to make or have made in a season and in none of these letters was there one word said about interest or depreciation. I figured over a number of their reports and found that these men in most instances were actually losing money while they stated in their letters that they were making money. They simply did not know how to keep their accounts if they were so disposed and most of them were not so disposed.

It has been only within the past dozen years or so that manufacturers have adopted close and accurate methods of cost keeping. When they did adopt such a system many experienced painful shocks of surprise. I knew of one firm of machine tool builders a few years ago who discovered after establishing a cost keeping system that on

certain tools that they had been manufacturing they had been actually losing money on every part turned out. Needless to say they proceeded to correct their mistake at once, but it was uphill business for a while to establish the higher level of prices and convince their customers they were justified in raising prices. However, it was the only sensible thing to do because a business that continually loses will soon go to pieces anyway.

For the thresherman or farmer a very simple system of bookkeeping is to be preferred. With a little study a man can easily invent a system for himself even if he knows nothing of the theory of accounts. What is needed is a system that will show the condition of the business at all times. That is all a set of books is for anyway, and the simpler they are the better, provided they give the desired information.

A day book in which are set down all transactions as they occur and a cash book recording all receipts and expenditures are the two important books.

If a thresherman has some other business such as farming he will find it advisable to keep a "threshing outfit" set of books. In this way he will not get his accounts confused and at the end of the season can find out where he stands financially. If he has a record of all receipts and all expenditures and takes into account his own labor as well as interest and depreciation he can figure out how much *he must charge a bushel for threshing.* If he is a good business man he will do this and if competition comes in and the price is cut he will know just where he must retrench to meet it, or better yet he can go to his competitor with his books and show him the truth.

The principal reason for the existence of the price cutter is *ignorance.* He does not know actual conditions and a little good educational work with him by a man who has the facts might do some good. The only way to cure price cutting is to compile accurate information on the cost of threshing in different localities and see that every man in the business be made acquainted with the facts. It would pay threshermen's organizations and manufacturers both, to gather accurate data on the cost of threshing, plowing, etc., and place it in the hands of all owners of rigs.

The farmers whose threshing is done need a little enlightenment in the same direction. In fact, every one connected with the threshing business from the manufacturer down needs to know more about the actual cost of threshing a bushel of grain, of plowing an acre of land, of grinding a hundred pounds of feed.

The business of threshing needs to be placed on a sound business basis where it pays a reasonably sure profit. If it were there would

be fewer failures of owners of threshing outfits and more in it for the manufacturers of such outfits. It is a bad deal for all parties involved when the security has to be levied upon to pay the purchase price of the outfit.

There is no sense in condemning the price cutter and holding him up to ridicule when no one, neither he nor his detractors, know the facts. I believe, after giving the matter careful consideration, that it would be a matter of sound business policy for manufacturers and threshermen's organizations to appoint a commission whose duty it would be to study this subject of actual costs in different parts of the country and place a copy of their report in the hands of every owner of a threshing outfit.

The matter of making settlements with customers is another matter upon which there has been considerable discussion, but since it is a vital question it will bear a little further comment.

Many threshermen are altogether too careless in this matter. They do not do business on business principles, and often come to grief in consequence. The proper method to follow is to make settlement when the job is done before moving to the next place. Let this settlement be in writing on a proper blank prepared especially for this purpose. This statement should be signed by the customer, and a similar statement should be made out, signed by the thresherman and left with the customer. In this way an exact record is made at the time; there is no chance for a misunderstanding afterwards due to poor memory and the transaction is businesslike throughout.

When it comes to the matter of the collection of accounts, the thresherman should be as careful and as diligent as the implement dealer or merchant or the thresher company that he bought his rig from. It is as much a part of the thresherman's business to look sharp after collections as it is to get threshing to do or to keep his rig in order. As stated on another page, the business end of the profession is the all important one and every move should be in strict accord with business principles. This does not mean that there should be any sharp practices, harshness in forcing collections or anything of that sort. People do not care to deal with that sort of a man, but everyone has confidence in the man who is straightforward, honest and business-like in his dealings. If he combines this with good, careful, conscientious work he will make friends and obtain the best business in his community.

CHAPTER II.

INVENTION OF THRESHING MACHINERY—EARLY HISTORY.

In reading the letters published in the Correspondence Department of The American Thresherman I have noticed a good many requests for a discussion of grain separators. It would appear that something on this topic might be of interest and my own observation in the field convinces me that there is as much need of instruction along this line as any other in the threshing business. The proper handling of a separator is just as important as the proper manipulation of the engine, and separator men are paid just as large wages as engineers. As a matter of fact there are probably fewer really good separator men than good engineers. It would seem advisable, therefore, to present some comments on the separator and this is what I propose to do.

From the time when the Lord rejected Cain's poor offering of the fruits of the soil down almost to the present time, agriculture, with a few exceptions, has not been an honored profession among the nations of the earth. For untold ages little was done to elevate agriculture to the position it deserved and which it has so recently achieved. The tools used in all its branches were crude and clumsy. Men exercised their genius in seeking ways to destroy life, not in means for preserving it. Swords and spears and cutlasses for mutilating the flesh, engines of torture for prisoners, devilish machines to send poor wretches to eternity—all these were invented and made, but nothing whatever to help make more bread to feed the starving millions.

Decades of centuries rolled by without seeing a suitable plow devised to stir up the soil, a harrow to fit it for the seed, or tools to gather the ripened fruits. All these things were evidently considered beneath and below the efforts of those who had the genius of construction. These were ages of false ideals and it is only recently, this morning as it were, in the history of the race, that the breezes of common sense and sanity have sprung up and blown away the enveloping fogs and mists of a miserable past with its gaunt specter Famine dancing and circling about, ever near and ever ready to spring out of the mists and wrap us in the cold embrace of Death.

The great nations of antiquity did not realize, apparently, that their one great and implacable enemy was Hunger. They did not realize that all other foes were pigmies in comparison. They cut and slashed and fought each other. Nations rose and fell, art and literature flourished. Great captains led mighty armies over plains and mountain ranges and across the deep waters in search of empire with never a thought for the great, common, mortal enemy of all.

Such is the wretched history of the past with its petty personal vanities, its court intrigues, its poverty and suffering, and its starving millions. It is only this morning, as I said before, that we have awakened to a new and better day. We have at last discerned the real enemy. We have made war upon him, dismantled his guns, stormed his barricades, and entrenched ourselves in the rich valleys and fruitful places of the earth where he can never again assail us. The Goliath of the centuries has been slain with the pebble of Science and Invention. It is the greatest of the world's decisive battles and the real beginning of a better civilization, for to be happy and content and to feel the real spirit of brotherly love man must first be fed.

When the Western nations first began to realize the absolute necessity for more food, they were confronted with the difficulty of obtaining it without proper tools. Crude instruments were at first devised for tillage and as the harvests of grain became large with their subsequent development it was found that the old method of hand shelling by women and children, the beating of the straw with a flail, or the treading out of the grain by oxen and horses was too slow and too expensive. Other means must be found and inventors took up the problem. They realized at once that either of the two century old methods were available. Either the grain might be rubbed out of the chaff as in hand shelling or it might be beaten out—as by flailing or the tramping of animals. It was evident that the successful mechanical thresher must be constructed upon one or the other of these principles. Both methods were tried, as I shall presently show, and both are in successful use at the present time.

A Scotchman named Michael Menzies was one of the first of a splendid group of men who experimented with threshing machines and his efforts, while not crowned with complete success, are worthy of notice as paving the way for subsequent experiments. His machine, which was brought out in 1732, consisted of a number of flails attached to a rotating cylinder driven by water power. It was capable of doing a considerable amount of work in a short time and attracted a good deal of attention. The frequent breaking of the flails, however, demonstrated the fact that the really successful machine would not make use of the flail motion in its original form.

The next threshing machine of which we have record was also invented by a Scotch farmer who succeeded in improving upon the Menzies' machine by constructing a rotary cylinder armed with beaters which for the first time correctly applied the principle of flail threshing to a power driven machine. His machine consisted of a vertical shaft supporting four cross arms all enclosed in a vertical cylinder. The grain was fed in at the top of the cylinder and the rapidly revolving arms beat the grain out of the straw during its downward passage. Both grain and chaff fell in a pile at the bottom and separation was afterward performed by hand in the usual fashion of the time by winnowing.

Twenty years later an attempt was made to solve the problem by using the rubbing principle of separating the grain from the straw. This machine employed a large fluted or corrugated cylinder which revolved between a series of small corrugated rollers which were held forcibly against the large cylinder by means of stout springs whose tension could be varied to suit the conditions of the grain. The friction between the corrugations of the rollers and the straw was depended upon to remove the grain from the heads. This machine was experimented with for some time with the hope that it would solve the problem. However, it, too, was found impractical, being slow in operation and liable to crack the grain. The rubbing or frictional machine appeared after these experiments to be valueless and again inventors turned their attention to the flail principle, which had been all but proven successful.

The pioneer work of the early investigators, whose work has just been discussed, led to the final solution of the problem a few years later by another Scotchman, Andrew Meikle by name, who constructed a thresher embodying all the essential features of the present successful machine. This machine, however, was a thresher only and not a combined thresher and separator such as we are so familiar with today.

The Andrew Meikle threshing machine marked a new epoch in the grain raising industry. Previous to his time there had been several attempts made to solve the problem of mechanical threshing but they were far from successful, though paving the way doubtless for the success which was finally achieved. Up to the advent of the Meikle thresher the principal method of threshing was with the flail. This was slow and expensive and besides was very wasteful. A large amount of grain was always left in the straw. All things considered it was out of the question at that time to raise grain on a large scale, and yet this was what the world was demanding more than anything else.

During the middle and latter part of the eighteenth century a great industrial revolution set in all over Europe, but more especially in England. Several things transpired to bring this about. James Watt invented, or rather perfected, the steam engine at this time and gave to the world a cheap portable power which could be used to drive machinery in manufacturing.

The cotton and woolen industries gained a foothold in England, there were wars on the continent and the demand for textile goods was enormous. Just about this time, too, spinning and weaving machinery was invented which, coming at the same time with the advent of the steam engine, turned England in a very few years to the greatest manufacturing nation in the world. This caused the cities and larger towns to flourish. Wages were high and laborers flocked from the rural regions into the cities where steady work at good wages could be had.

All this reacted upon agriculture. It created a greater demand than ever for agricultural products to feed the factory workers, and raised the prices of farm produce to prices heretofore unheard of, but at the same time it left the agricultural districts with insufficient help.

Necessity again became the mother of invention. For the first time in the world's history a pecuniary reward was held out for the invention of labor saving machinery and this proved a much stronger incentive than the mere alleviating of human suffering or the fear of famine.

Inventors immediately set to work to solve the various problems involved in building labor saving agricultural machinery, and within a few years after the opening of the nineteenth century, we find at least crude designs of all the leading types of farm implements which are so common and familiar at the present time.

Among the very first to be experimented with was, as previously stated, the threshing machine; and it remained for Andrew Meikle to show to the world the correct principles which must obtain in a successful thresher.

His machine consisted essentially of a revolving cylinder having four beaters faced with iron and extending outward from the body of the cylinder about four inches. A pair of feeder rolls were placed just in front of the beater between which the grain was compelled to pass on its way to the beater. These served to retard the straw until the beaters had knocked the grain out of the husks. The first machines built were over feed machines, that is, the straw was fed in over the top of the cylinder which revolved in a direction exactly opposite to that of the modern thresher. Instead of concaves there

was a fairly close fitting cover fitted behind and partly around the cylinder.

Behind and below the cylinder there was a set of slowly moving rakes which separated the straw from the chaff, the former passing backward to the rear of the machine, the latter together with the grain falling through a grating to the hopper of a fanning mill below.

These machines were made in various shapes and sizes suitable to be worked by hand, by horse or power, by wind wheels or by water wheels. The small hand machines were worked with a crank, two men and a woman usually constituting the threshing crew. The larger machines were built in place and were rather expensive for the farm, especially where the tenant system of farming prevailed as it did in England, and where the tenants were obliged to furnish all the machinery and tools for doing the work. Consequently, only those who worked considerable land on long term leases could afford to invest in the larger machines. The small tenant farmer was obliged to still use the more primitive methods or else the less expensive and less efficient hand thresher as is still done today in many parts of Russia.

Gray gives the following rather interesting account of one of these threshers driven by a large wind mill: "The machinery of the wind power of this machine is fitted up with a small vane to turn the large ones to face the wind and with the machinery to roll the sails on or off, according to its increase or diminution; by which means the naturally unsteady power of wind is rendered as regular as that of horse or water. The threshing part of this machine contains the usual apparatus, and also a complete set of fanners or screens for cleaning the grain. To the board upon which the unthreshed grain is spread, and introduced between the feeding rollers, succeeds the drum, with the threshers, or beaters, fixed upon the extremity of its arms; then the shaker, that receives the straw from the threshing drum, and conveys it to the second shaker, by which it is thrown down a sloping searce either on the low floor, or upon a sparred rock, which moves on rollers, turned by the machine, and by this means is conveyed into the straw shed, or else into the barn yard. One searce is placed below the threshing drum, and while the drum's circular motion throws out the straw into the straw shaker which conveys it to the second shaker, the chaff and grain pass at the same time down through a searce or sparred rock into the hopper, which conveys it into the fanners. By the fanners the corn is separated from the chaff, and the clean grain running out at the opening, and the chaff or any light refuse blowing out at the end by the rapid motion of the fans, which are driven by a band or rope from the sheave placed upon the axle of

the threshing drum, and passing over the sheave fixed upon the pivot of the fans."

The next improvement of note in European machines was the substitution of a toothed cylinder and concaves, also with teeth to take the place of beaters. A little later a straw carrier or elevator was added which, with a winnowing machine or fanning mill, made up all the essentials of the modern grain thresher. These machines, to be sure, were large and clumsy. Their capacity was much less than those of the present day, but they were a great improvement in every way over the old hand methods which they supplanted.

Moreover, any marked advancement in one phase of any industry brings with it a new set of needs which is bound to react on every other branch of that industry.

And so the advent of the power thresher made better harvesting tools and better tools of tillage a necessity and these quickly followed during the succeeding century—that century of mechanical marvels—the nineteenth. And not the least of these marvels were the many and wonderful farming implements. But at the beginning of this list, which includes all that we have now, stands the grain thresher.

The early experimental work on threshing machines was done in Scotland, but in this as in most other great inventions, no one country or one individual is entitled to all the credit. While the correct fundamental principles of threshing were worked out across the sea, it remained for American inventors to perfect all the numberless small details which go to make up the successful machine that we are today familiar with. In fact, the perfecting of the many small mechanical devices which make up any complete machine requires more labor and as high an order of genius as it does to conceive the original crude idea. Indeed, in talking with some of these later day inventors and listening to their tales of unexpected difficulties met with and the experimental work which they performed before achieving final success, I am inclined to think their task was the harder. Some of these difficulties will be taken up and discussed subsequently when we begin studying the various details of the complete machine.

It is not definitely known whether the first threshers used in this country were made here or imported from Europe. In any event they were rather crude, simple affairs.

It is reported that as early as 1825 there were some simple threshers used in the United States, but it was not until three years later that the subject appears to have attracted the attention of inventors very seriously. About that time a man named Samuel Lane of Hallowell, Maine, took out a patent on a traveling thresher fitted with harvesting attachments. Another patent was issued to the same inventor

four years later, but neither proved commercially successful and are mentioned herein merely to fix the date of the active improvement in this line of machinery.

The first inventors of note, whose work influenced all subsequent development, were two brothers, Hiram A. Pitts and John A. Pitts of Winthrop, Maine.

Their first invention in 1830 was an improvement on a tread power which afterward became quite popular throughout the New England states for operating the old-fashioned "ground hog," "bull threshers," "bob tails," "chaff pilers," etc., as the old open cylinder machines were variously called. These machines were simple affairs which merely threshed the grain out of the straw without doing any separating. All the chaff and grain fell at the rear of the machine where it was afterward cleaned in a fanning mill after the coarser stuff had been removed by hand labor with the use of forks.

It was while operating one of these old "ground hogs" that Hiram Pitts conceived the idea of combining it with an ordinary fanning mill. This had been done some years before in Europe, but it was the first time the idea was tried in the United States. This idea was worked out in detail by the Pitts brothers during a period of several years and in 1837 they were granted a patent. This was the beginning of the "endless apron," or "great belt" separators as they came to be known. This machine contained most of the fundamental features of the present day machines. It was provided with a "beater" and "picker." The endless apron ended at the "picker." Both beater and picker were armed with spikes and resembled those in use at the present time. The purpose of the picker was to throw the straw from the machine. This machine was also provided with a tailings elevator, but instead of returning the tailings to the threshing cylinder they were retained at the sides of the machine, from which point they were carried to the fanning mill for refanning.

From this time to the present day there has been constant improvement in the threshing and separating devices of grain separators. The Pitts brothers blazed the way for all other inventors of this class of machinery. Both brothers continued in the business until they died. Hiram A. Pitts finally went to Chicago and engaged in the manufacture of the old "Chicago-Pitts" separator, which became well and favorably known all through the grain growing section of the country. John A. Pitts finally went to Buffalo and engaged in the manufacture of the Buffalo-Pitts machines. This company became incorporated in 1877 and in 1880 began the manufacture of threshing engines.

The Chicago-Pitts concern went out of business many years ago, but the Buffalo-Pitts Company is too well known to need any further comment. Hiram Pitts died in 1860 and John Pitts in 1880.

The most important and, I may add, almost epoch making improvement in separating machinery was the introduction of the vibrating principle. There was not very much difficulty, even at this early date, in getting the grain out of the heads, but to get *all* of it out of the straw was a problem. It was comparatively easy to get the most of it.

The European machines with a series of pickers did very good work. So did the early Pitts machines with their inclined belt and pickers, but the trade demanded perfection and this was the problem inventors spent sleepless nights over.

To save all the grain—that was the problem. The Pitts experimented some with a vibrating device in the early "thirties" in connection with the old "ground hog" threshers, but it remained for later experimenters to prove that this was the correct principle.

The pioneers in the development of this principle were John Cox and Cyrus Roberts. About the same time that most adventurous spirits were wending their toilsome way across the Great Plains to California they were building "ground hog" threshers at Belleville, Illinois.

In experimenting with a separating device to be applied to these machines they hit upon the idea of an inclined platform, built of lumber, with side boards attached. The bottom of the platform was bored full of holes and was given a longitudinal motion by means of a crank and pitman. This aided the "forkers" at the rear of the machine and effected partial separation, but of course it was not wholly successful. This principle was developed during the next ten years and in 1852 Mr. Roberts took out a patent on the device. Later on, the machine was further perfected, the fanning mill was added and a really first rate machine was constructed which went on the market as the Cox and Roberts thresher.

The principle involved in this machine was not fully recognized as being the correct one until some years later, when in 1858 the Nichols & Shepard Co., of Battle Creek, Michigan, began manufacturing them, the original firm of Cox and Roberts having gone out of business.

In the original Nichols & Shepard machine there was but one shaker and the plan was to allow the straw to pass back from the cylinder upon a series of fingers which lifted and tossed the straw, somewhat as a man might toss the straw with a fork—these fingers having a sudden up and down motion. With only one shaker the machine

had considerable end shake, but this was largely overcome by putting in another shaker operated by a crank having its "throw" opposite to the first one. This machine was christened by Mr. John Nichols "The Vibrator." From this time on he gave it his undivided attention and in many ways perfected the mechanism.

In 1867 the Aultman & Taylor Co., of Mansfield, Ohio, through a Mr. Taylor, obtained an interest in the vibrator patents and also began the manufacture of a vibrator machine.

Up to this time two types of threshers had been evolved, the endless apron thresher and the vibrator. The former was modified to some extent by Westinghouse and Wemple, who substituted a raddle working over square tumblers which gave the straw a vertical as well as a horizontal motion. Others made the raddle travel over eccentric rollers which served the same purpose.

Both types of threshers had considerable merit, but in the end the vibrator principle with many modifications and improvements triumphed, and practically all threshers at the present day make use of the principle.

It required many years of close study after this before ultimate success was obtained. In fact, it was not until some time in the "nineties," more than sixty years after the first patents were issued in this country, that we saw what might be called a perfect thresher. Previous to this time experimentation and change were the order of the day. In the nineties, however, we may say, that for the first time the grain thresher became standardized. Weighers, feeders, blowers, etc., were perfected during this decade and the perfected machine as we know it today came into being. There have been some improvements since and there will undoubtedly be more in the future, but the heavy work is done.

We will next take up a discussion of some of the details of the separator as we know it today. In this brief account of its birth and growth we have omitted the names of many men and companies that contributed very largely to the development of the perfected machine, and have only mentioned a few whose efforts stand out pre-eminently.

In a book of this kind it is not the purpose of the writer to go very deeply into the history of the subject, but rather to take up the subject from the operator's point of view. However, a brief glimpse into the history of the separator seemed advisable at this point. As we progress we hope to be able to enliven the story by personal reminiscences of some of the men who have been active in the development of the machine.

CHAPTER III.

SEPARATION AT THE CYLINDER.

For purposes of study and investigation it is always necessary to make some sort of classification of the subject under discussion in order to avoid unnecessary repetition, and also to be certain of covering the entire subject and pointing out the relation of any one part to every other. This is the method that is applied, either consciously or unconsciously, whenever a careful study is made of any subject; for without some such method some parts of the subject may be overlooked altogether, some may be given more prominence than they deserve while others of equal or even more value are passed by hastily.

Applying this principle of study to the grain thresher we find that the subject naturally falls into the following divisions, namely: the frame work, the feeding mechanism, threshing mechanism, separating and cleaning mechanism, grain handling devices and straw handling devices.

While it would perhaps be more logical to begin with a description of the frame work of the machine and then take up the other divisions in the order given, I am, however, for reasons of convenience, going to vary the order somewhat and consider the threshing mechanism first.

The *cylinder* is the principal agent for loosening the grain from the straw, and since it is of prime importance in the operation of a grain thresher it has received very careful attention at the hands of designers. The first cylinders were *beaters,* consisting of a revolving piece supporting four parallel wooden bars which were placed parallel with the axis of the cylinder. Since that time the cylinder has undergone numerous changes until it has finally evolved into the present form of a toothed cylinder revolving at high speed, the teeth of which pass between similarly formed teeth set in the concaves below.

While there are some modifications in the general design of cylinders, the differences are exceedingly slight. Figure 1 taken from a well known manufacturer's catalog shows the general style of construction. The heads at the end of the cylinder are solid cast iron and two central heads are provided to give support to the bars. These latter are made of steel and are punched with square holes to receive the shanks of the teeth. Heavy wrought iron bands, which are shrunk in place, hold the bars rigidly to the cylinder heads. The shaft is keyed to the heads, which are provided with liberal hubs

for that purpose. The whole structure is thus roughly but substantially made. There is little or no machine work done upon it, but the work is rather carefully done, nevertheless.

It is the practice of some builders to place strips of hard wood underneath the cylinder bars against which the nuts, which hold the teeth in position, may be set up. This provides an elastic cushion for the nuts and helps to keep the teeth tight. Others depend upon split steel spring washers to hold the nuts from working loose. The heavy tension of the spring washer jams the nut against the threads of the tooth shank and prevents turning.

After the cylinder is completely assembled, and the teeth are in place, the next operation is to put it in balance, that is to add weights wherever there is a deficiency. This operation consists first of putting it in *static balance* and afterwards in *running balance.* In the first operation the cylinder is set up in a frame made for that purpose and given a push by hand to set it revolving. If one side is lighter than another, that side will be uppermost when it comes to

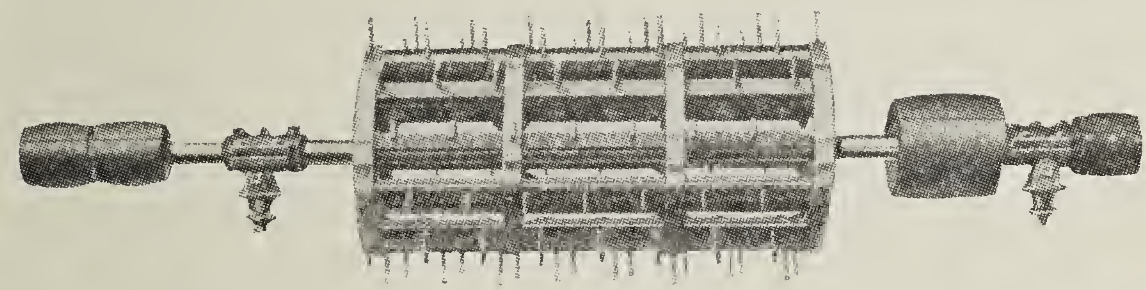


FIG. 1. A STANDARD TWELVE BAR CYLINDER.

rest. By placing weights on the light side it is possible to balance the cylinder in such a way that it will stop rotating, sometimes with one side uppermost, sometimes with another. The next operation is to give it a running balance, that is, to speed the cylinder up and then dispose of the weights in such a way that it will run steady with the least possible vibration.

This process is one that requires a great deal of skill and experience as there are no rules or processes that will enable the workman to tell with certainty where the balancing weights should be placed. It may be stated in passing that a revolving body may be put in static balance and yet be out of balance when running at high speed. If the balance is not correct it causes vibration of a more or less violent nature which causes injury to the boxes and to the entire machine.

It will be noticed on examining the accompanying figure that the teeth are arranged spirally on the cylinder drum, and are placed in such a way that they pass corresponding teeth in the concaves at a

distance of about one-eighth of an inch. There is, on all separators, an end adjusting device, whereby the cylinder may be slightly shifted endwise in order that the cylinder teeth may divide the distance between concave teeth exactly right. This correct spacing is very essential in order to obtain the best results. If the space is too small, grain will be cracked, and if too large at other points some of the heads will pass through without being threshed. For the same reason teeth that are bent, broken, or badly worn should be replaced by new ones. It should be noted also that where new teeth are inserted to take the place of old worn ones, care should be exercised to place them opposite each other, on opposite sides of the cylinder. If this is not done the cylinder will be out of balance. A fraction of an ounce of weight placed wrong will make considerable difference in the smoothness with which the cylinder will run if speeded up to its normal working speed.

The teeth should be frequently tested to see if they are tight, especially if the machine is new. This may be done by tapping them with a hammer or drawing an iron rod quickly across a row of teeth. A special wrench is used to tighten the nuts and whenever a loose one is found it should be tightened at once. Right here I want to call attention to an important precaution that should never under any circumstances be neglected. If it becomes necessary to make any repairs or adjustments to the cylinders or concaves while the engine is under steam and the belt is on, *make sure that the throttle of the engine is closed, that the reverse lever is in the center notch, and the cylinder cocks are open.* If you take this precaution you may turn the cylinder and feel safe that it will not suddenly start running, otherwise you may turn it half over and it will set the engine going with the steam trapped in the cylinder, and you are liable to be injured.

Sizes of Cylinders.—Cylinders constructed with twelve bars are known as standard cylinders. This is the size that was in general use for a number of years. At present in addition to the twelve bar cylinders there are some made with sixteen, twenty, and twenty-one bars. The small cylinders run from 1,050 to 1,150 revolutions per minute, and the large ones from 700 to 900 revolutions. It has been found in practice that the correct speed of the teeth for threshing is in the neighborhood of 6,000 feet per minute. In order to obtain this speed in all cases it is necessary to run the small cylinders very much faster than the large ones. While the threshing speed is roughly given at 6,000 feet per minute and this speed will be obtained by running at the speed stamped on the front of the machine, it does not follow that deviations from this speed are not permissible. As

a matter of fact, under certain conditions of grain a change in speed is necessary in order to obtain best results. When the straw is tough and slightly damp the speed must be increased somewhat above the normal; when very dry it may be kept at or just below normal. The exact speed is a matter for judgment and experience to decide. It depends upon the condition of the straw and the kind of grain. Rules in such a case are useless, and the only guide to correct procedure is the judgment of the separator man. Since this matter of cylinder speed is quite essential to correct practice, the operator in charge should make free use of the speed indicator and make sure in starting that he has the required cylinder speed as indicated on the front of the machine. If the grain is somewhat damp he should have the engineer speed up the engine a little at a time until he obtains the best results. From fifty to seventy-five revolutions above normal are usually sufficient increase to take care of any condition of dampness.

The Cylinder.—The standard or twelve bar cylinder ranges from twenty to twenty-four inches in diameter measured from tip to tip of the teeth. The large twenty and twenty-one bar cylinders range from thirty-two to thirty-six inches in diameter. The rotational speeds of the cylinder vary from 700 and 900 revolutions per minute in the large sizes to from 1,050 to 1,200 for the small cylinders. This gives a circumferential speed to the teeth of a little more than 6,000 feet per minute as the following calculations will show. Take for example a twenty-two inch cylinder rated at 1,075 revolutions per minute as given in a certain manufacturer's catalog. The circumference of the circle described by the points of the teeth is $3.1416 \times 22 = 69.1$ inches, which is the distance a tooth will travel in one revolution of the cylinder $.69.1 \times 1.075 = 74{,}282.5$ inches, which divided by 12 to reduce to feet, gives a circumferential speed of 6,190.2 feet per minute. In other words, the teeth travel through space at this speed, which is about at the rate of one and one-fifth miles per minute.

A similar calculation for the thirty-two inch cylinder shows a tooth speed of 6,281 feet per minute, which is very slightly in excess of the speed of the small cylinder. An investigation of a number of different makes of separators shows that all have adopted practically the same tooth speed. The correct speed for the cylinder as well as the speeds of the various racks and other parts of a separator, while of the utmost importance, have been arrived at only after long and patient trials in the field. The men who made the first grain separators had no precedent to follow, no theory upon which to base their judgment. Theirs was a cut and try process from beginning to end.

Large vs. Small Cylinders.—There have been many arguments advanced and endless discussion over the relative efficiencies of the large and the small cylinders. For a long time the large cylinder was a good "talking point" as it gave opportunity to advance some very plausible arguments in its favor. The balance wheel effects, large grate area, non-slugging properties, etc., were all put forward as strong claims. There is, moreover, considerable truth in all the statements, but it is now acknowledged that there is not the great advantage in the large cylinder that was once claimed for it. The large size and great weight give it a balance wheel effect. That is, when up to speed it has a tendency to remain at that speed. On the other hand, when once slowed down its inertia will tend to keep it from speeding up immediately. It is slower to respond to the power of the engine than the small cylinder, and it will slug just as surely as the small cylinder, though probably it will require a somewhat larger bundle of wet straw to do the job. The large cylinder runs slower than the small one, it is true, and its driving pulley is larger, but the distance from the points of the cylinder teeth to the rim of the cylinder pulley is greater than in the case of the small cylinder and hence the braking effect of the bundles passing through would appear to be greater.

Originally the large cylinder was brought out in order to obtain a larger grate area. This was found necessary if any improvement was to be made in the saving of grain, for at the time the large cylinder was brought out inventors had just come to realize that the place to save the grain was at the cylinder where it is loosened from the straw and not back along the racks, where they had been working so long. The idea was to keep all the grain, or at least as much of it as possible, from getting into the straw at all. To accomplish this required a larger grate area and the easiest way to get this appeared to be to build a large cylinder. This was done and the results appeared to justify the means.

Mr. Seth G. Wright of the Buffalo-Pitts Company showed that it was possible to get as much grate area as needed with a small cylinder, by simply carrying the grate concentric with the cylinder as far around as desired and elevating the beater and keeping it close to the cylinder, allowing only about an eighth of an inch between the beater spikes and the ends of the cylinder teeth. Then as the straw came around the cylinder, it was caught at the ends of the grates by the beater and whipped over onto the straw racks. At the same time the loosened grain flying upward with the impetus given it by the cylinder would strike the smooth side of the beater drum and be deflected downward upon the grain pan. Mr. Wright found in experimenting

at this point that it was possible to deliver the straw as high as he desired, even carrying it completely around to the top of the cylinder by continuing the grates that far, and then placing the beater at a corresponding height. He also performed another interesting experiment while studying this problem of saving the grain, and according to his story, it was on account of this experiment that he arrived at the conclusion that the point to work on to *save grain* was at the cylinder. He fitted glass sides in the separator at the ends of the cylinder and placed a light at one side so that he could look through while the machine was in operation and see the straw going through. What he saw astonished him. Instead of a thick blanket of straw as he expected, all he saw was a few scattering straws passing through at enormous speed. This was somewhat in the nature of a revelation to him and set him to work in an attempt to save the grain at a point where the depth of straw was the thinnest, with the results above outlined. A little thought regarding the relative speeds of the different parts of the machine would, of course, have led to the same results. The speed of the cylinder teeth, and consequently that of the straw, is about one and one-fifth miles per minute, while the speed of the straw on the racks is only a few hundred feet per minute. Consequently the straw blanket at the cylinder must be very much thinner than on the racks. It was the actual sight of this condition, however, that set him to work in the right direction. At the present time all of the different separator builders have by one means or another, arranged their machines to save the greater part of the grain at the cylinder instead of allowing it to pass on into the straw and effecting separation on the racks, as was the practice formerly.

The Cylinder Shaft.—The cylinder shaft is made very large and strong for several reasons. The resistance of the straw is considerable and when a wet bundle goes through and "slugs" the machine the twisting stress on the shaft is enormous. Again, if some teeth are knocked out while the cylinder is rotating at high speed the lack of balance would deflect a small shaft a considerable amount, but has little effect on a large one. In case of a fire around a stack the shaft is supposed to be strong enough to permit of pulling the separator out of danger with the belt.

The cylinder shaft boxes are also made strong and heavy and self-aligning, that is, they are pivoted on the center so there is no possibility of their binding the shaft through the twisting of the separator frame. The length of the bearing is generally made about three and one-half to four times the diameter of the shaft. This ratio of diameter of shaft to length of bearing was worked out for general machinery many years ago by the Wm. Sellers Company of Philadel-

phia and it is a good safe rule to follow. It is a rule that is adopted by some of the largest machinery builders in the country and I mention the fact here because many of our readers are experimenting with new machines and it may come in useful.

Lubrication of Cylinder Boxes.—The lubrication of the cylinder boxes is a matter of the utmost importance. In some machines ring or chain oilers are used, thus following the practice of the builders of dynamos, fans and other high speed machinery. This system of oiling consists of a reservoir in the pedestal below the shaft, filled with oil, into which a ring or chain dips and which rests on and revolves with the shaft. The ring or chain, coming up through the oil, carries a certain amount of the oil up and spreads it on the shaft. This is a very good method of lubrication and has been proven quite successful. Another plan is to use a grease cup and hard oil. This also works well, but it requires a little more attention than the chain oiler for the reason that, as usually constructed, the compression cups are hand operated.

One of the greatest difficulties encountered in lubrication is due to running the drive belt too tight. This squeezes all the oil out from between the journal and the bearing and is the cause of many hot boxes.

In setting up a new separator the cylinder boxes, blower boxes, and all other boxes which are liable to get filled with dust or grit during a long railroad journey, should be taken apart and cleaned thoroughly. This precaution only takes a few hours' time and is sure to pay in the cool running of the boxes and the assurance one feels that everything is right.

It is stated in nearly every manufacturer's catalog and quite generally accepted that, to be successful, a thresher must separate most of the grain from the straw at the cylinder. This is accomplished in a variety of ways which will be shown later on by illustrations suitable for the purpose. It was stated heretofore that the large cylinder was brought out originally for this purpose and there is no doubt but that it has been successful, especially in combination with a suitable arrangement of concaves and grates. At any rate its introduction marked the beginning of a careful study of the front end of the machine, which has resulted in the present rapid and altogether successful thresher. One of its manifest advantages, often pointed out, is the large driving pulley which provides for a large area of contact for the drive belt, thus considerably reducing the tendency for belt slippage.

So far as is concerned the power necessary for operating either the large or small cylinder, it is not likely there is very much difference.

Under certain momentary conditions one cylinder may run harder than the other, as for example in starting, the inertia of the large cylinder, due to its great weight, absorbs considerable power for a moment. This, however, is not lost but is returned as useful work when the teeth strike a wet bundle and the speed slightly slackens.

Cylinder Teeth.—The teeth used in the cylinder are made in a drop press from bars of a tough hard steel which contains carbon enough to take a mild temper, but not so much as to cause brittleness. A brittle tooth would not only be useless but dangerous. The material of which teeth are made must be such as to meet the exacting requirements of very hard usage and this is found in what is known as a mild tool steel or rather hard machinery steel.

While the steel used is often specified as tool steel, and there is a good basis of fact for the claim, it nevertheless is not a crucible steel such as is used in fine tools, but a good grade of open hearth steel.

The size and shape of the teeth are important considerations. With the advent of large cylinders and large separators, designed to do heavy work, it was found advisable to make stronger, heavier teeth. These teeth act as cantilever beams in doing their work and according to the theory that beams should be wider at the shank than at the points, but as a matter of fact the contrary construction prevails. The reason for this is twofold: first, the wear due to abrasion comes mostly near the tips of the teeth, and second, the teeth should have some surface in order to rub the grain out of the straw at the time it is passing through the corresponding teeth in the concaves. The necessity for this rubbing effect is clearly shown in the case of grain that is difficult to rub out of the heads, like Turkey red wheat or Durum. The teeth generally recommended for these wheats are corrugated. These corrugations hold the head from rolling or slipping and rub the grain out of the head in passing a similar concave tooth. Where seed is difficult to separate from the chaff, like clover seed, a similar form of tooth is used. Here, then, is where the old rubbing principle which I mentioned in the first part of this chapter finds its present day application.

In some machines the cylinder teeth differ in form from the concave teeth, but the modern tendency is to make them the same. This is not difficult to accomplish and makes less trouble and confusion in the field to have them interchangeable.

Where the flattened upper portion of the tooth meets the shank it will be noticed there is a large fillet or easy curve joining the two parts. This is a necessary feature of design to obtain the required strength. If a square corner or small fillet were provided the tooth would be weak at that point. This principle is nicely illustrated by

a little experiment I once performed on a hard steel bar. The bar was turned in a lathe to exact size, and then given two cuts of equal depth near the middle, one with a V-pointed tool and the other with a round nosed tool. The bar was then pulled apart in a testing machine and broke at the V notch. Several repetitions of the experiment always brought the same result.

The spacing of the teeth and the number used in the concaves have a marked effect upon the quality of threshing done. If the teeth are not spaced right, that is, if the cylinder teeth do not divide the spaces between the concave teeth about equally, grain will be cracked on one side and some whole heads are liable to pass through on the other. If too many rows of teeth are used in the concaves, the straw will be cut up and there will be a heavy burden of chaff on the sieves, which will make the work of separation and cleaning difficult. The ideal way to thresh is to merely beat the grain out of the heads without breaking up the straw at all. This is, of course, impractical in rapid mechanical threshing, but any breaking of the straw more than is absolutely necessary not only makes difficult separation but consumes power and in that sense becomes expensive.

The exact number of rows of concave teeth which should be used can not be stated off hand. In very dry wheat four rows are found sufficient. Where four rows are used it is customary to place a blank in front, then a double row of concave teeth, another blank, and finally another double row of teeth near the rear of the concave circle. Where the grain is damp, six rows are necessary. This is all that is usually provided with the machine, but, if wanted, concave bars holding three rows of teeth each can be obtained, making it possible to use nine rows of teeth. The safe rule to follow with regard to the number of rows of concave teeth to use is this: Use just as few as will do the work properly. Any more than this will merely clog the sieves, consume power, and result in poorer work being done.

Every machine is provided with some sort of concave adjuster or device to move the concaves to or away from the cylinder. Some machines have these adjusters placed both front and rear so that either the front or the rear of the concaves can be made to approach or recede from the cylinder as desired. The majority, however, have only the one adjustment in front, the concave circle being hinged at the rear. The proper adjustment depends upon the condition of the grain. If heads are passing through unthreshed, the concaves should be set up as it is evident that they are passing through the open space between the points of the concave teeth and the cylinder drum.

Returning again to the matter of cylinder teeth, we show herewith illustrations of the various shapes in which they are made, and the

method used for securing them in position. The most of them depend upon a square shoulder or shank to keep them from turning, and a spring washer underneath the nut to lock it and keep it from working loose. This matter of keeping the nuts tight is very important, as a

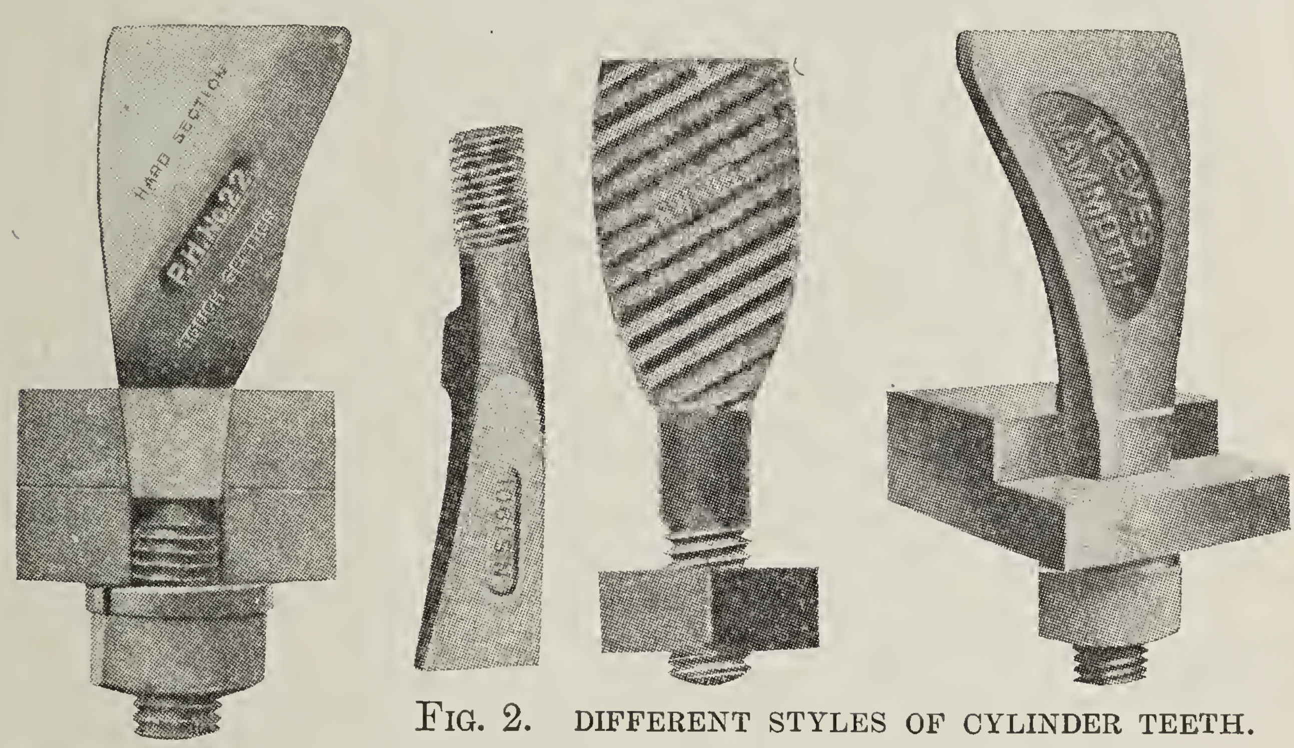
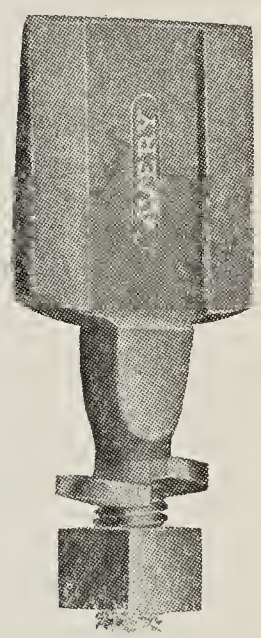


FIG. 2. DIFFERENT STYLES OF CYLINDER TEETH.

little looseness in the teeth will cause them to wear the holes in the cylinder bars badly and make it impossible ever after to make them fit. The square shank, spring washer, and nut are shown in the Reeves-Mammoth teeth. Another method of holding the teeth is shown in which the tooth is keyed. Some special method of holding is necessary in every case for the reason above stated and because the strain on teeth is at times very heavy.



The general forms of cylinder and concave teeth do not differ very greatly except in special cases where a corrugated concave tooth is used for threshing clover, alfalfa, Turkey wheat, or some grain that is hard to thresh. The N. W. No. 4 and Avery are examples of teeth of this class. Then there is another class of large extra heavy teeth of which the Reeves-Mammoth and Advance are examples. These are adapted for use in the large cylinders. Being extra heavy they are not so apt to bend or break.

In some machines the same form and size of tooth is used for both cylinders and concaves, while in others it requires a special form for each. The Case tooth shown is an example of one of the interchangeable teeth, but the Case is by no means the only machine that is so designed.

In addition to the special forms of concave teeth for threshing the refractory cereals, some machines are provided with studded concaves, that is, concaves having projections like bolt nuts in between the teeth. These, to a great extent, it is claimed, prevent unthreshed heads from passing through beyond the points of the teeth.

Cylinder Draft, or *Suction,* as it is sometimes called, may be defined as the capacity the cylinder has of drawing straw into the machine. This differs slightly in some machines, due to differences in design which may be accidental or intentional.

An inspection of American separators will show that in all cases the straw is fed into the machine well below a horizontal plane passing through the center of the cylinder. Also, that the feeder table slopes sharply toward the cylinders from a point about the length of a bundle from the cylinder teeth. Up to this point the feeder carrier carries the bundles up a slight incline, which prevents them from rolling or sliding toward the machine. If the straw were delivered to the cylinder above the horizontal plane, considerable grain would be thrown back on the feeder and the cylinder teeth would have a tendency to push the straw back instead of drawing it in. In other words, the draft would be negative. If straw were delivered exactly on the horizontal plane, there would, theoretically, be no draft, either positive or negative. When the straw is delivered at some point lower down on the cylinder, the draft becomes stronger. With cylinders of the same size, and run at the same speed, the draft is dependent *solely* upon the angle at which the straw is delivered to the cylinder. It will be greatest when the slope of the feeding table is exactly tangent to the cylinder and correspondingly less as the plane of the table intersects the cylinder more nearly along some diameter.

Concaves and Concave Frames, as can be seen from the various illustrations, consist either of heavy castings or of heavy pressed steel sections. In any event they are, and should be, made extremely heavy and strong to bear the heavy strains which are liable to occur when a wet bundle, or a pitchfork, or block of wood accidentally goes through the machine.

All concaves are made to be adjustable to or from the cylinder either at the front or rear, and some of them at both points. Where only one adjustment is provided, it is in front. The amount of adjustment is limited by the throw of a cam or of an eccentric shaft

and is such that in their highest position the concave teeth are in no danger of touching the cylinder. An examination of some of the figures will show the schemes used for concave adjustment.

Separation at or Near the Cylinder.—It has been pointed out that the straw passes underneath the cylinder at the rate of something like six thousand feet per minute. The amount passing through, ordinarily, at any single instant is very small—only a few straws, relatively speaking. All of the grain that is threshed out of the straw is, of course, threshed by the cylinder. The greater part of this grain we know is thrown straight down through the concaves and grates upon the grain pan below, but there is a considerable portion that is caught by the whirling cylinder teeth and thrown backward and upward. This portion is thrown in among the straw and is the part which must be separated out on the straw racks. It is also possible that some few kernels may slightly adhere to the heads of the grain and be shaken out by the action of the beater, and by subsequent agitation on the racks. The amount of grain passing the cylinder unthreshed, however, must be exceedingly small; consequently the function of the beater, straw racks, and separating devices, which make up the bulk of the machine, is to take the grain out of the straw that was thrown into it by the cylinder after it was threshed out of the heads.

Now let us investigate the reason why the grain is thrown into the straw in such quantities. The straw, under the action of the cylinder, passes through the concave teeth at the rate of from five to six thousand feet a minute, the speed being a little higher in some machines than in others. The beater, picker or whatever device may be placed immediately back of the cylinder reduces the speed of the straw to less than fifteen hundred feet per minute and the check board checks the flying straw for an instant before it is caught by the racks. From this point to the rear of the machine the speed imparted by the racks is only from thirty to fifty feet a minute. The total time from the moment the straw reaches the cylinder until it passes out at the rear of the machine is less than half a minute. During this time it has traveled about twenty feet and at several widely different speeds. When the speed of the straw is checked at the beater it causes a pile of straw to form back of the cylinder which catches all the flying kernels of grain. Here, then, is the real cause of most troubles in separation. It is not an easy difficulty to solve and perhaps the various experimenters and builders have done all that is possible, but it has occurred to the writer many times that if the straw could be carried back by a swift moving raddle in the same thin blanket that exists beneath the cylinder, to a

point beyond where grain would be thrown into it, a machine might be devised whereby the separation would be effected without racks or agitators. There would be some serious obstacles to overcome in making such a machine and it might not be at all practicable when completed. However, it has served my purpose of calling attention to what takes place at or near the cylinder and will make an understanding of the various machines perhaps a little clearer.

The aim of designers apparently has been to prevent as much as possible the loading of the straw blanket just back of the cylinder, in the first place, and in the second place to shake out as much of the grain as possible before passing it on to the straw racks.

The pictures of the various machines which we are showing herewith show how some of the different designers and builders have sought to attain similar results. We will endeavor to explain some of these devices at some length, but will refrain from passing judgment as to the merits of one machine over another, because it would, after all, be merely a personal opinion which might not be verified by competitive trial. Since no such trials have ever been undertaken, the reader will, therefore, be asked to form his own conclusions after we have presented the material and put it in proper shape for consideration and comparison.

Nichols & Shepard. The first one to engage our attention among the large cylinder machines is the Nichols & Shepard. The grates are carried well beyond the cylinder but not concentric with them, and then rise at a very steep angle in a device called "The Man Behind the Gun," which is clearly brought out in the illustration. The device extends above the middle of the cylinder and consists of open slat work with a check plate behind. The object is to allow the flying kernels to pass between the slats, strike the check plate and be deflected downward on the grain pan. The beater wings just clear the cylinder teeth and the top of the check plate and whip the straw over and at the same time is supposed to deflect any flying grain downward.

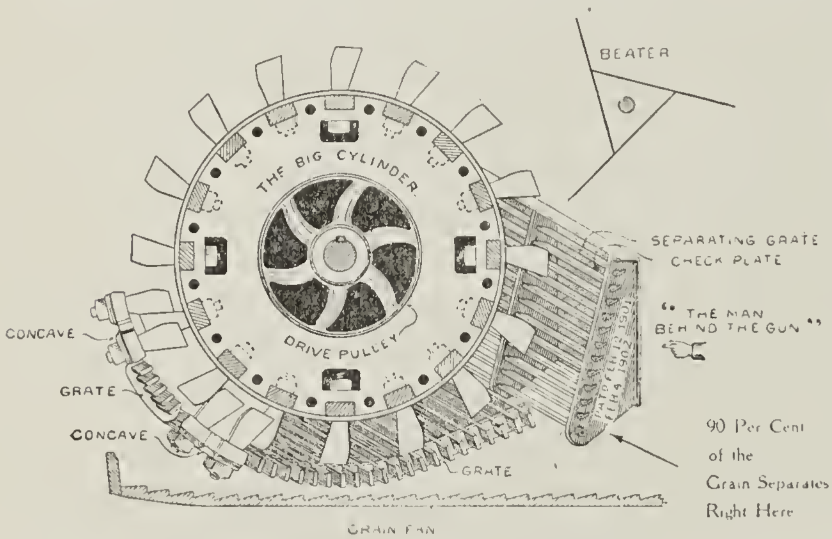


FIG. 3. CYLINDER AND GRATES OF NICHOLS & SHEPARD MACHINE.

The Case separator comes next among the big cylinder machines. It, too, has a very large grate area—fifty-two inches in all. The illustration shows how the grates and concaves are made up and it also shows the pressed steel frame work and concave holders.

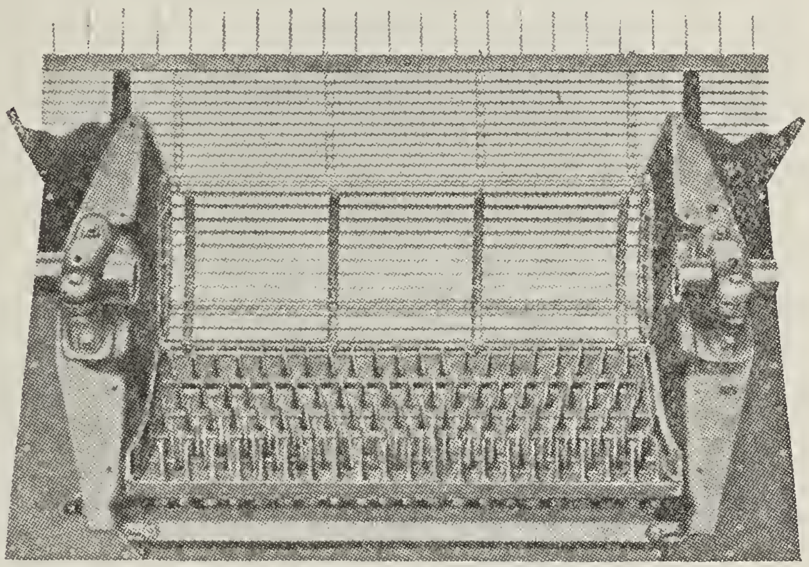


FIG. 4. LOOKING DOWN ON CONCAVE AND GRATES OF CASE TWENTY BAR CYLINDER.

The rear end of the grates overlaps the first straw rack a short distance. The beater is of sheet metal construction composed of four arcs of circles with the concave parts set next to the shaft. The peculiar form of the beater is such as to deflect any grain which strikes it either straight down or else back toward the cylinder. Then, just back of the beater, there is a check board to prevent flying kernels that escape the beater from being thrown too far back into the straw.

The *Avery Company's* separator is the first of the small or medium cylinder machines we will consider. This machine is provided with as much concave and grate surface as any of the large cylinder machines. They are arranged in three sections of eighteen, fourteen and twenty inches respectively.

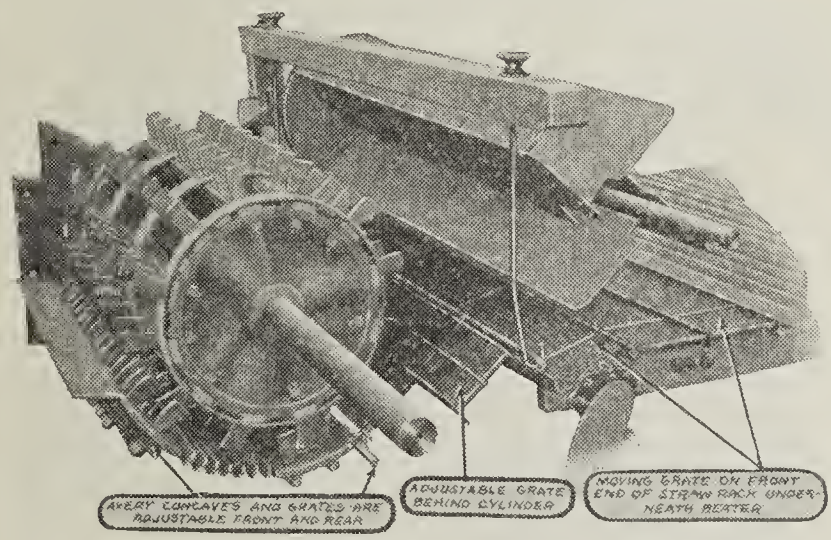


FIG. 5. CYLINDER CONCAVES AND BEATER OF AVERY SEPARATOR.

The concave section is adjustable both front and rear, the middle section is made adjustable, while the third section oscillates with the separating racks. The beater is made with four wings and has its axis slightly above the axis of the cylinder. A check board is placed immediately behind the beater. In this machine the straw is delivered to the racks only slightly above the bottom of the cylinder.

Buffalo-Pitts.—Here a large grate area is obtained by carrying the grates well around and concentric with the cylinder, which is of medium size. The beater is smooth and cylindrical with backward curving teeth which almost touch those of the cylinder. The straw is carried up almost to the beater, and is then thrown lightly upon the racks. Much of the grain passes through the lower grates, some strikes the smooth sides of the beater and is deflected downward, while a certain small percentage is thrown back into the straw. The first straw racks are set high and much of the flying grain should strike through the grates directly upon the grain pan.

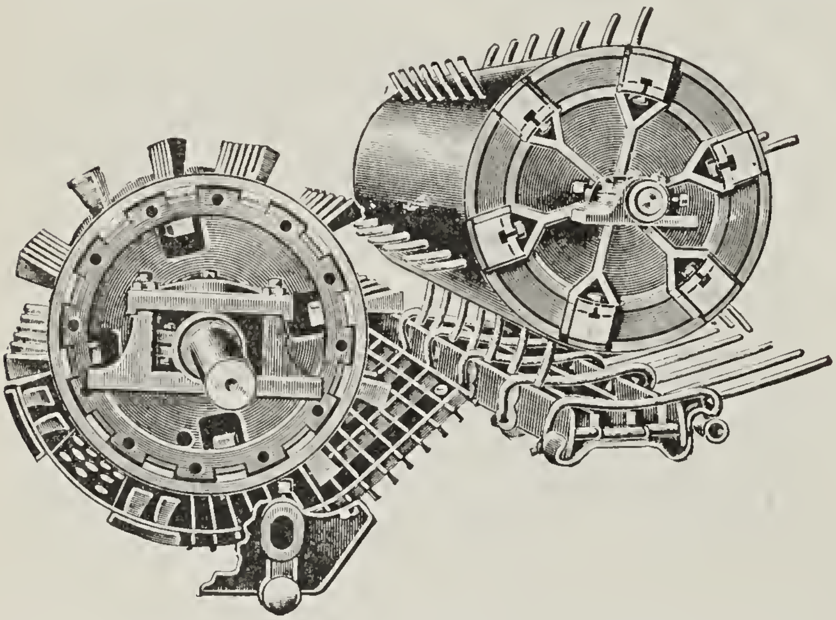


FIG. 6. CYLINDER, CONCAVES AND BEATER CYLINDER OF BUFFALO-PITTS THRESHER.

The Geiser Manufacturing Company's separator differs quite widely from the others we have described in some respects. It has a small or medium sized cylinder and the straw is delivered on a level with the lower side of the cylinder. Immediately behind the cylinder and a short distance from it there is an abruptly rising grate through which the teeth of a revolving drum project. These forks pick up the straw and throw it lightly upward, where it is caught between a pair of beaters and whipped over upon the racks.

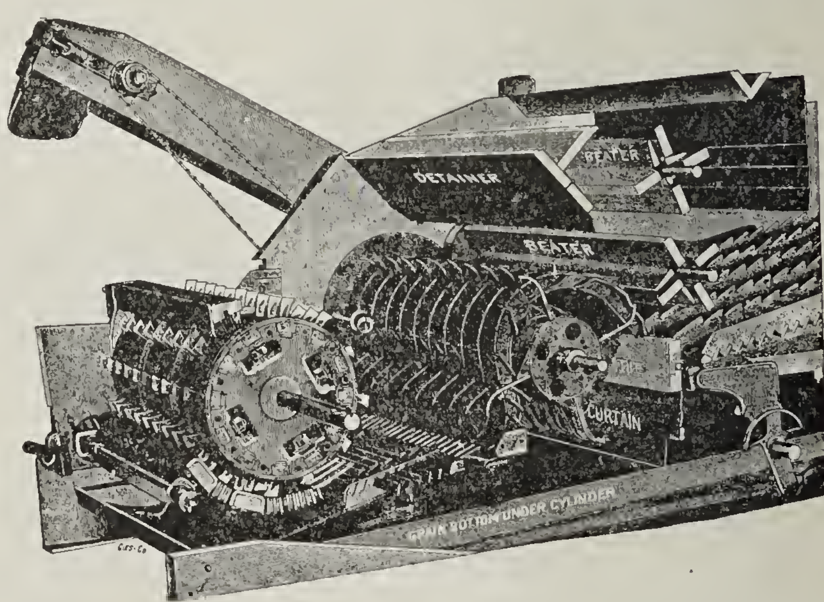


FIG. 7. GEISER ABRUPTLY RISING GRATE.

The Frick Company's Eclipse separator is another separator which deserves especial mention on account of some peculiarities of design. It has a large grate area placed concentric and extending well past

the middle of the rear of the cylinder. The first straw rack is placed high above the buttom of the cylinder so that very little of the grain thrown through the grates can find its way into the straw. The beater or picker as it is called in this machine is placed rather farther away from the cylinder than in most machines and higher above the racks. It is provided with a number of blades or large teeth placed helically on the beater body. The cylinder consists of a steel tube with an inner lining of hard wood through which the teeth pass. A special wrench which is worked from the end of the cylinder is used to tighten the nuts of the cylinder teeth. The teeth are of special form, having the back edge similar in form to the front so that when worn they may be turned half around, or the cylinder may be turned end for end in the bearings.

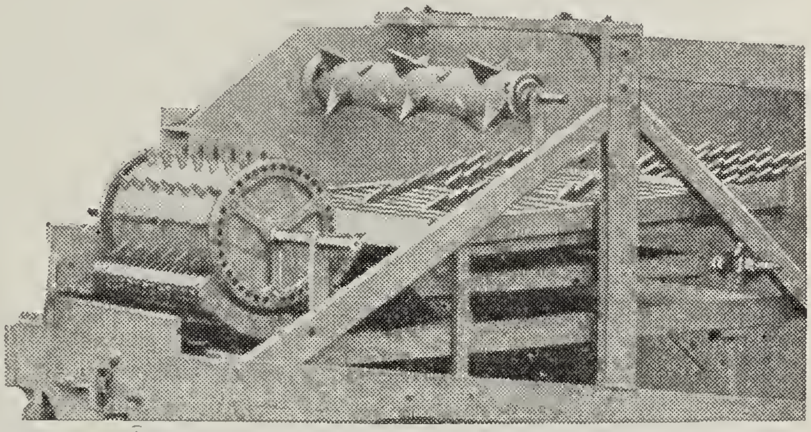


FIG. 8. FRONT END OF FRICK SEPARATOR.

The *Wood Brothers* Humming Bird is one of the simplest machines on the market. The cylinder is set well down below the straw racks, and the straw is delivered on a level with the bottom of the cylinder, to a steep vibrating grate or rack which elevates the straw three feet six inches to the straw racks. There is no beater and the straw is thrown at full cylinder speed of the vibrating racks. At the beginning of the first straw racks some wire springs are hung from the roof of the separator which reduce the speed of the straw to that of the separating racks.

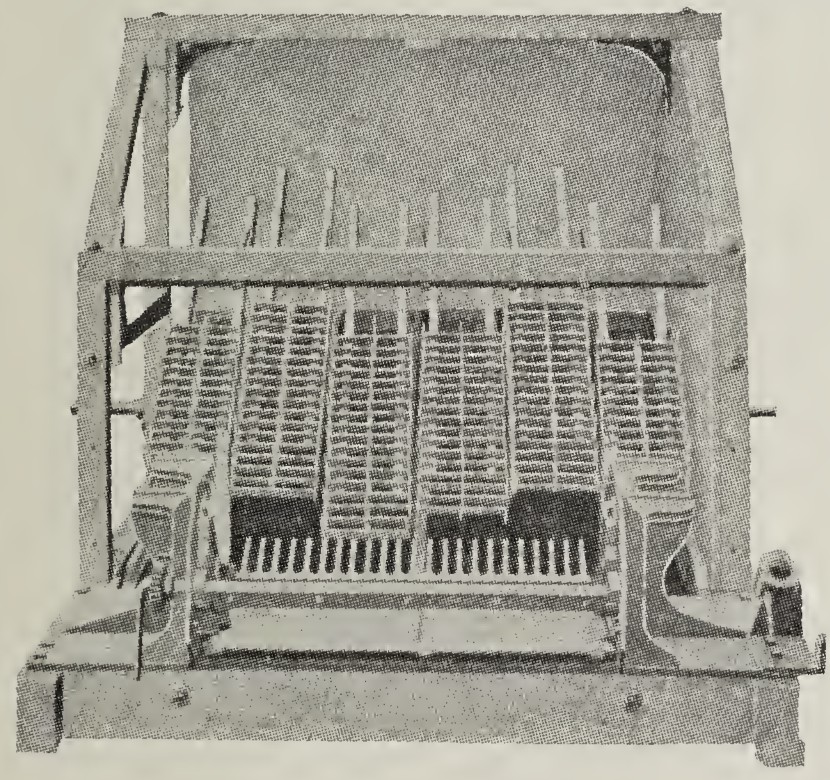


FIG. 9. GRATES IN WOOD BROS. THRESHER.

These racks are made in five sections and operated by means of a multiple crank so arranged that when one section is up the adjacent section is down. This has the effect of agitating the straw and tearing the bunches apart.

The *Huber* separator depends upon the following principles for separation at the cylinder: A considerable distance to the first straw rack, two beaters running in opposite directions between which the straw must pass, and a flexible deflector back of the beaters which prevents the grain from being thrown back into the straw. The accompanying illustration shows the features of construction very clearly.

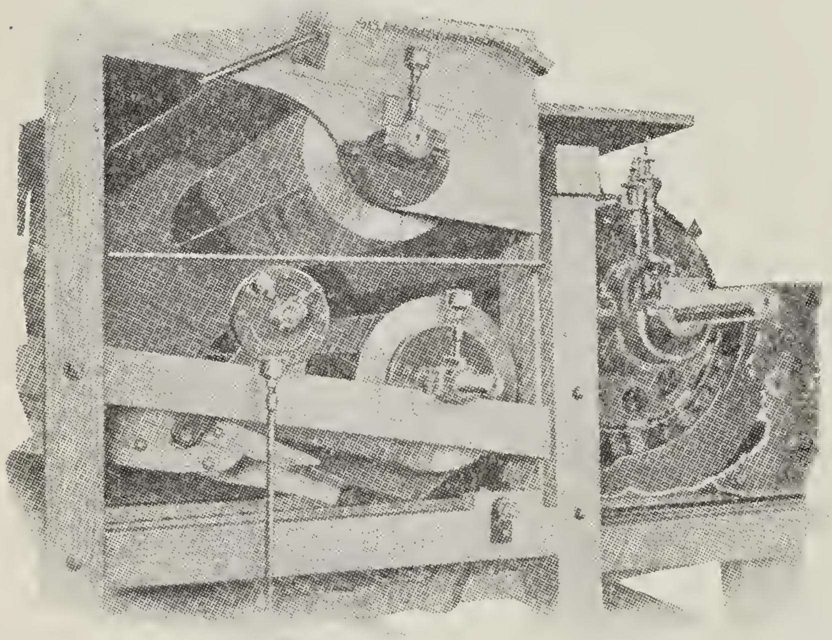


FIG. 10. FRONT END OF HUBER MACHINE.

The *Baker* separator is fitted with a small cylinder. The first section of the grate right back of the cylinder is inclined at a very steep angle and ends in close proximity to the wings of the beater. Back of this set of grates and extending well under the beater, is an open slat work or auxiliary grate which is given an up and down as well as a rearward motion by means of a crank attached to the grain pan.

The beater is of peculiar construction, having a square central core to which are attached curved blades so arranged that the point of the winged blades enters the straw first and spreads it. As the straw breaks sharply over the first set of grates, it is struck by the beater and spread toward the sides of the machine. This is done ostensibly with the purpose of preventing the middle of the racks from being overloaded. It is a well known fact that the teeth midway between the ends of the cylinder wear out first, thus indicating that the largest amount of straw passes through at that point. This leads many designers to believe that it is well to use some device to spread the straw. Furthermore, the racks are usually several inches wider than the length of the cylinder and this is additional reason for some sort of spreader. There are many designers who believe a spreader is not necessary, and depend merely upon the vibration of the machine and the natural spreading action of the cylinder and beater.

The *Reeves.* The next big cylinder machine to claim our attention is the Reeves. It has the usual large grate area, but differs from some of the other machines in having a separating rack that extends well down underneath the cylinder, and extends at rather a steep angle

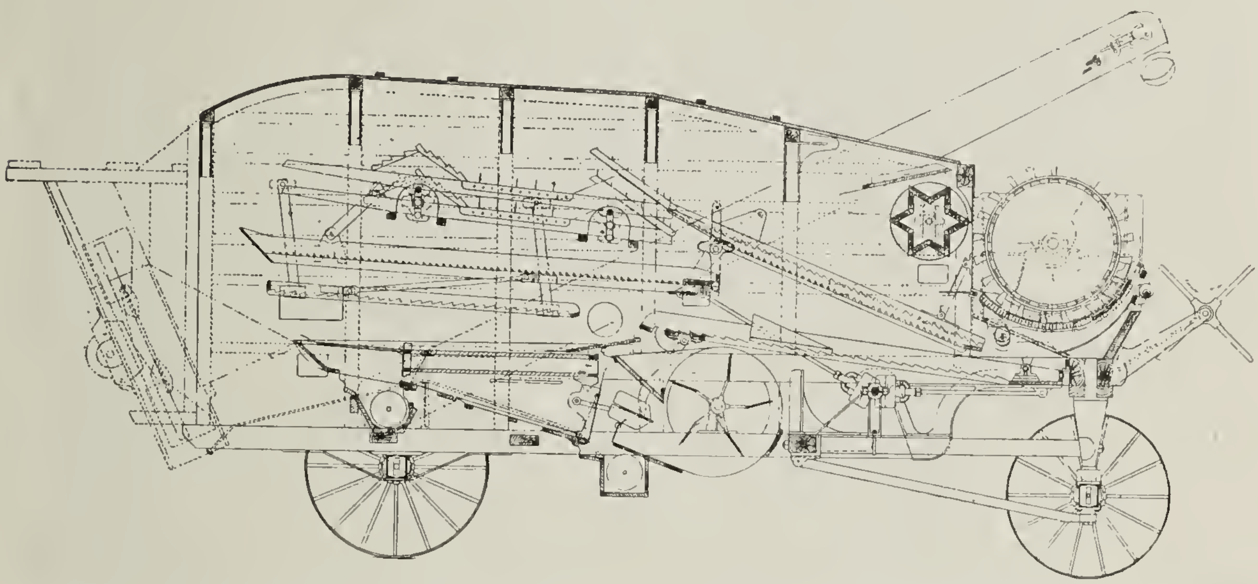


FIG. 11. SECTIONAL VIEW OF REEVES SEPARATOR SHOWING BIG CYLINDER AND DOUBLE RACKS.

upward so that it must catch any kernels that escape the beater. The beater is star shaped and placed directly back of the cylinder, with a check board above it and the first rack close underneath. The concaves are adjusted both front and rear.

The *Rumely* machine has a medium sized cylinder in connection with large grate area, as indeed all modern machines have. The cylinder is set well below the separating racks as in the Reeves and a raddle or endless carrier elevates the straw. The beater just clears the raddle and serves to distribute the straw evenly over the machine and at the same time tends to deflect the grain through the open slat work of the carrier. At first thought this contrivance might seem to embody the ideas which I briefly hinted at in another place, but it actually comes no nearer to it than any of the others I am describing.

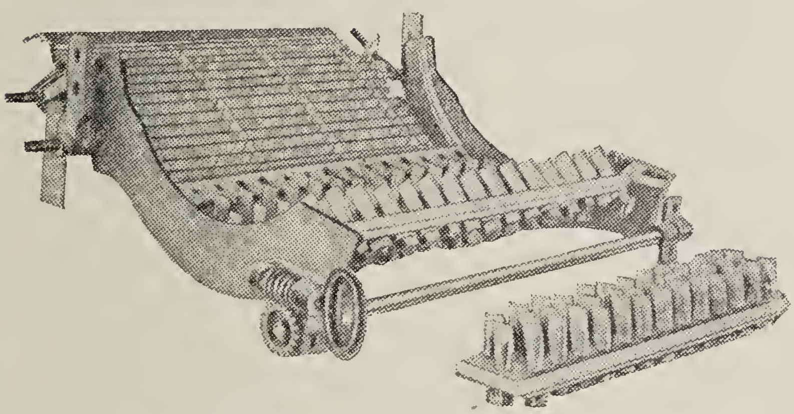


FIG. 12. CONCAVES AND METHOD OF RAISING OR LOWERING IN RUSSELL SEPARATOR.

The *Russell* "Cyclone" thresher is provided with a large cylinder and two spiral wing beaters or spreaders set well back of the cylinder and only a short distance above the racks. The grates are arranged in such a way that the straw is thrown up against the first beater, which strikes it from above and throws the grain forcibly down toward the grain pan.

The *Advance* thresher is provided with a pair of forks placed immediately back of the cylinder, which are operated by a two-throw crank. The grates extend straight back from the lower part of the cylinder for a short distance, and then curve upwards keeping concentric with the path traced out by the points of the forks. The grates are in this way very greatly increased in area. The forks toss

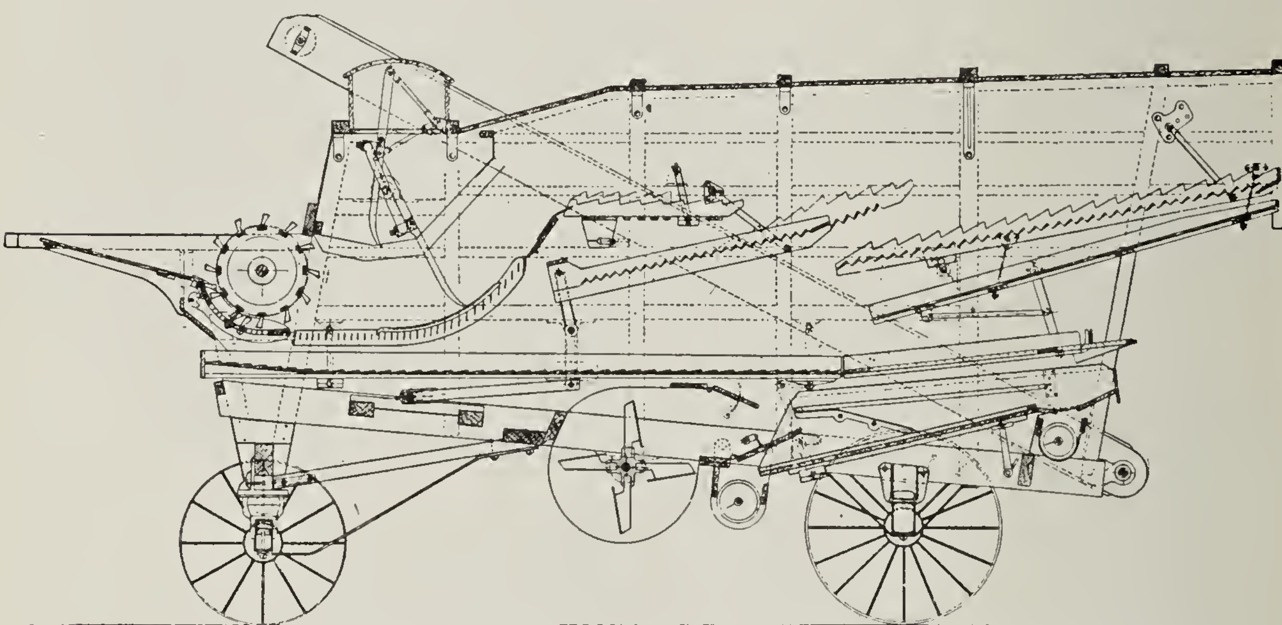


FIG. 13. SECTIONAL VIEW OF ADVANCE-RUMELY SEPARATOR.

the grain upon a straw rack which is placed well above the cylinder and a considerable distance back of it. The flying kernels, therefore, nearly all shoot through the curved grates and fall on the grain pan underneath the straw rack.

In all of the machines which we have described there seems to be only one point upon which they all agree and that is upon the necessity for a large grate area. Features which are considered of the utmost importance in one machine may be entirely ignored in another and, in many cases, not even a substitute is provided to make up the deficiency. Yet in spite of all this, all of the machines are capable of doing good work when properly handled. It may be true, and probably is, that some machines will bear crowding much better than others, but upon this point we have no absolute and exact information. This much, however, appears to be certain: when we

consider the great difference in construction close to the cylinder there must be a considerable difference in their separating capacity at that point. We do not suppose there may be any great difference in the effectiveness of the different machines as a whole when the straw is finally disposed of, but there must be a difference in the effectiveness of some of the different parts of the various machines. In other words, some machines must do more separating on the straw racks than do others. Whether this is a serious disadvantage or not is an open question, and one which we do not propose to discuss at this time, but will leave it to the designers and operators to fight out among themselves.

We have shown the different machines and discussed with more or less thoroughness the differences in design and the methods employed for separating the grain from the straw at or close to the cylinder. On a subsequent page we will consider the principles made use of for further separation on the straw racks.

CHAPTER IV.

METHODS OF SEPARATION ON STRAW RACKS.

In the old days of flail threshing or threshing by driving cattle or horses over the threshing floor, the long straw and coarse stuff was separated from the grain and chaff by men with pitch forks. They operated by throwing the straw into the air with forks and then catching it as it descended. When the rapidly rising fork struck the bunch of straw it administered a sudden sharp blow which had a tendency to throw the straw upward and away from the kernels of grain and at the same time tore the bundle of straw apart and thoroughly disintegrated it. This allowed the heavier grain to fall to the threshing floor. When done carefully and conscientiously, it was a very effective method of separation.

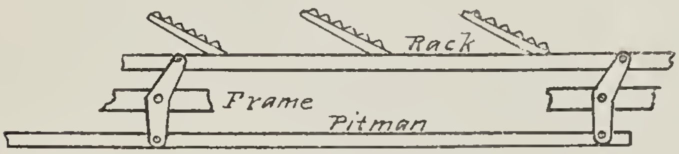


FIG. 14. METHOD OF PIVOTING TO IMPART CONVEX MOTION TO RACKS.

When men came to build mechanical separators they tried a number of methods of separating grain from the straw, such as beaters, pickers and raddles or revolving belts. These latter were often given a vibratory motion by being run over irregularly shaped pulleys. For slow threshing, where the straw blanket was quite thin, these various devices did fairly creditable work, but when the days of fast threshing arrived they were apparently found inadequate because all of the large grain threshers of the present day make use of the old principle exemplified by the man with the pitch fork. Even where the raddle is now used, and it is still used to a limited extent, it is always in connection with a vibrating rack.

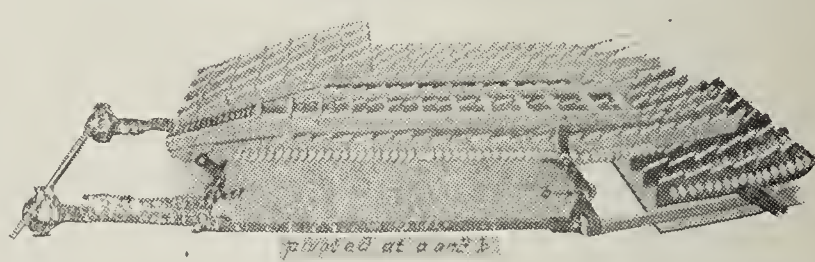


FIG. 15. STRAW RACKS OF OLD NORTHWEST SEPARATOR.

In order, then, to separate the grain and chaff from the straw most rapidly and effectively, it is necessary to make use of the pitch fork principle. In other words, the designers of separators approximate as closely as possible the action of the man with the fork. That is,

they arrange a set of fingers to throw the straw into the air and as it descends the fingers again strike the straw from below and continue to so toss and strike it while it is passing from the cylinder to the straw carrier at the rear of the machine.

A careful study of the principles of separation of the straw racks leads to the enunciation of the following principles which must obtain in all well constructed separators. First, the straw blanket must be thin and must be spread evenly over the entire width of the rack. Second, the straw must not only be thoroughly shaken but every straw must be made to move with reference to its neighbor. Third, all bunches of straw that reach the racks must be torn apart and thoroughly disintegrated in order that no lodging place may be left for a kernel of grain. Fourth, the motion of the racks must not be so violent that any of the grain is thrown up and out of the blanket of straw. Fifth, the length of the racks and their speed must be so proportioned that the straw will be carried rapidly through the machine and yet be allowed sufficient time for all of the grain to settle to the grain pan below. To accomplish all of these results in a machine that handles, in one day, all of the straw that grows on a quarter section of land, and that is the capacity of some of our large modern threshers, is not such an easy task as it might at first appear. In fact, it has taken years to so perfect machines that they are able to accomplish such remarkable results. The various ways in which this problem has been solved will furnish the text for the remainder of this chapter.

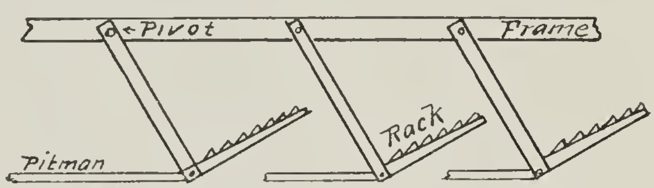


FIG. 16. METHOD OF PIVOTING TO SECURE CONCAVE MOTION.

The Pitch Fork Idea is carried out in a variety of ways by the use of suitable link work or a combination of cranks and links. Figures 14 and 16 illustrate two methods that are often employed. The former imparts a convex motion to the rack when viewed from above, the latter, a concave motion. In figure 14, in which an indirect link is used, that is, one that is pivoted near its mid point, it will be noticed first of all that the links when in their normal position of rest, do not stand vertically, but are inclined with the vertical through an angle of about thirty degrees. This is an important point to observe as upon it depends in large measure the action of the straw rack. This can readily be explained by referring to the figure. In the normal position the rack stands at the lowest point in its travel. When started in motion it moves upward and backward with a quick

motion, being in that part of the circle where the motion is about equal in both directions. This tosses the straw upward and backward. Before it has time to fall back on the rack, the latter is again on its up stroke and strikes the straw from underneath a vigorous blow which again sends it up and backward. This is repeated a great many times until the straw is finally pitched out at the rear end of the machine, but on its way it is tossed very much as a man with a fork would toss it. This action, it will be observed, has a tendency to throw the bottom straws backward faster than the upper ones, with the result that the bunches of straw are well torn apart. The speed of the racks is such that the straw moves at the rate of about one hundred feet per minute. The throw of the racks is only a few inches and so gauged that the grain is not thrown violently out of the straw. Figure 15 shows how this principle is applied in the old Northwest separator.

In figure 16 the motion of the racks as looked at from above, is not convex as in the first case, but concave. The racks again start from their lower position and move upward along the under side of the circle. This has a tendency to again throw the lower part of the straw backward faster than the upper part, thus imparting to the straw a sort of backward rotary motion, which is quite effective in tearing all bunches apart and allowing the grain to fall freely to the grain pan. These racks may all be worked together, or each worked separately, depending upon the ideas of the designer.

Another principle which is frequently employed consists of a rack divided into a number of parallel sections which receives motion from a multiple throw crank placed at the rear of and below the racks. The crank shaft is so constructed that when one section of the rack is in its lowest position its adjoining mate is in the highest position. The result of this action is to tear the blanket of straw apart and agitate it very thoroughly. The fact that the sections are narrow and that the straw bridges across from one section to another makes it evident that upon the upthrow of each section it will come violently into contact with the straw and strike it a considerable blow, at the same time moving only a part of the blanket backward while the adjacent part has no such motion imparted to it at the given instant. This, of course, has a strong tendency to disintegrate any bunches that may have come through the cylinder. This means of agitating the straw blanket is used on a number of modern machines and has proven quite successful in the field. The multiple throw crank shaft works in wooden boxes attached to the upper part of the rear end of each section. These boxes are not as much affected by the dust and grit as metal boxes would be.

A combination of rotary motion and oscillating motion is illustrated in the skeleton view of the Gaar-Scott separator, figure 17. In this machine the cylinder end of the first rack is supported by a hanger or link which swings back and forth along the arc of a circle. The rear end of the same rack has a circular motion imparted to it by the crank. All points in between move in elliptical paths. The rear rack has the same motion with the ends reversed, consequently as the straw passes from the first rack to the second it is violently agitated and torn apart.

The number of kernels in a bushel of wheat as determined in the Thresher World contest in 1903 was 869,762. That is a large number of parts for a bushel to be divided into and it is not to be wondered at that a few of them should get lost in going through the

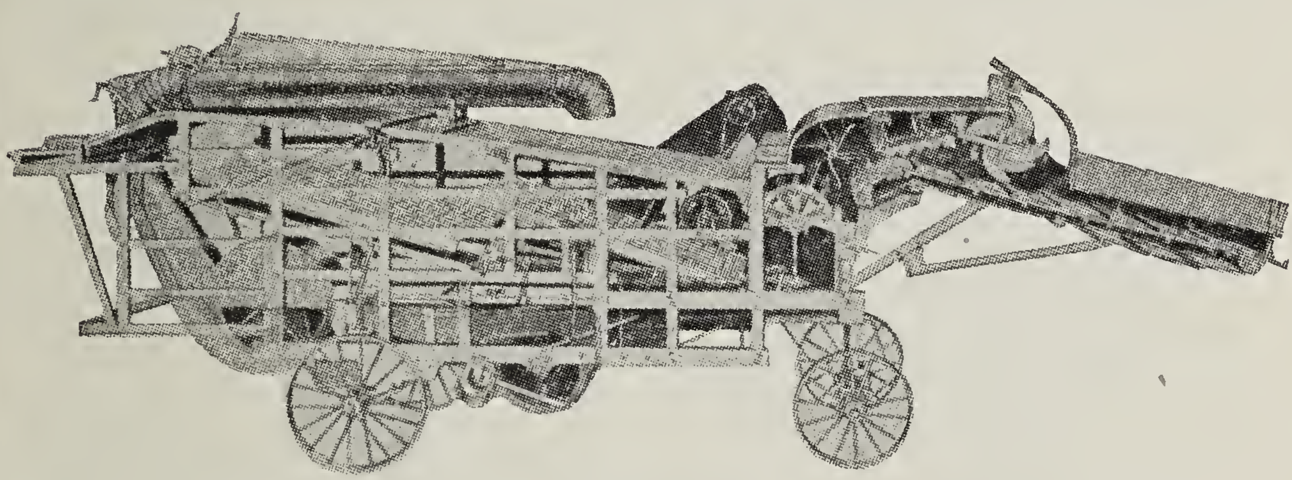


Fig. 17. sectional view of gaar-scott separator out on land.

separator, and they do. There isn't a machine made that will save every kernel and there probably never will be; but machines have been so far perfected that the loss is negligible. When a bushel is so finely divided, quite a good many of the parts may be lost in a minute without amounting to very many bushels in a day's run. For example, in a ten hours' continuous run it would require a loss of 1,450 kernels per minute to amount to a single bushel. In the same time a large sized machine should easily thresh 1,500 bushels. If only one bushel were lost—and it isn't likely any more would be lost in the straw—because 1,450 kernels per minute would make quite a considerable of a storm and that would undoubtedly provoke another and quite different kind of storm; if, as I was saying, only this one bushel were lost by being blown out with the straw, it would amount to only one-fifteenth of one per cent of the day's threshing. That is not a very large loss and it goes to prove that apparently a good many kernels of wheat may be lost without causing the loss of very many bushels. In fact, any of the machines now on the market, when well

adjusted, will waste very little grain by blowing it into the straw. This source of loss is perhaps the least that either the thresherman or the farmer has to contend with.

While the loss of grain to the straw stack may be kept down to a small percentage of the total, it can not be entirely eliminated. There will be some loss through leakage at the joints of the machine, some on account of unthreshed heads that pass out with the straw, and some that will be blown out with the chaff, besides a little free grain that will go directly into the straw. The latter is perhaps the smallest single source of loss about the machine, but the one that is the most apparent.

On a previous page I showed several devices by which separation on the straw racks is effected. In every case the same ultimate object is sought, namely, the thinning of the straw blanket and the

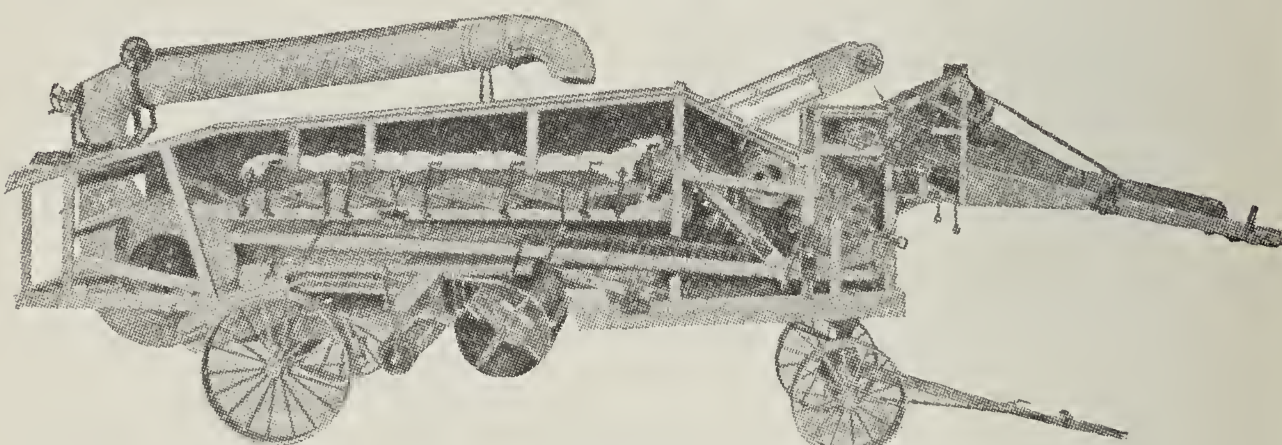


FIG. 18. SECTION RUMELY SEPARATOR.

tearing of it apart so that no resting place will exist for any free grain. Merely bouncing the straw up and down on the racks will do very little good, no matter how violently this is done, unless it is at the same time torn apart. Without going into detail there were shown several ways in which the straw might be agitated. We will now continue this discussion at greater length.

Referring to figure 18 it will be noticed that we have in this machine an illustration of a single rack with the usual slat work bottom through which the grain can fall and provided with a series of fingers over which the straw is compelled to rise and fall down again before reaching the next set of fingers or risers. The breaking of the straw blanket over the different sets of fingers and the penetration of the mass by these fingers breaks the straw up quite effectively.

In figure 17 two racks were provided and the straw was obliged to fall some little distance to pass from the upper one to the lower. This, coupled with the further fact that the motion of both racks is

most violent at this point, has the effect of tearing all bunches apart and allowing the grain to fall out. It is evident from a study of the illustration that the bulk of the separation must occur at this point.

Another means for agitating the straw is shown in the Aultman & Taylor Company's "New Century" separator, figure 19. Here a number of notched fingers, each formed in the arc of a circle and mounted on a multiple crank shaft below the rack, penetrate the straw blanket from below at each revolution of the crank and carry the straw forward. These fingers are arranged so that while one is acting on the straw the next one to it is below the surface of the rack on the opposite stroke. There are several of these shafts, each with a set of fingers, and the result is a very thorough agitation of the straw before it passes out at the rear end of the machine. The fact that the motion is a rotary one instead of vibratory adds to the steadiness of the running of the machine.

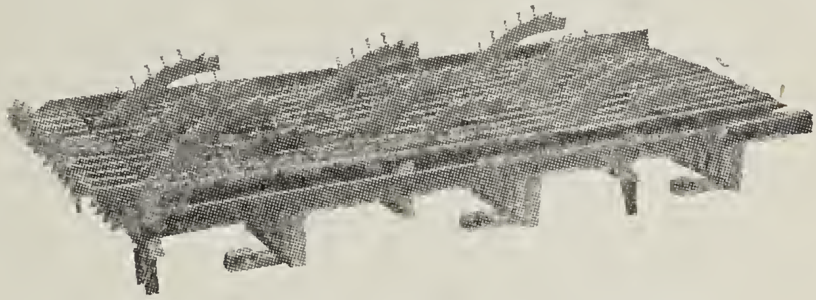


FIG. 19. STRAW RACKS OF AULTMAN & TAYLOR MACHINE.

Another interesting machine is shown in figure 20. In this machine, instead of a long continuous rack, there are a number of short racks, each having an oscillatory motion. Each of these racks is driven by a separate crank which causes it to swing up and down and thus throw the straw from one rack to the next beyond. The effect is to beat the straw violently from the under side and to cause the straw blanket to be broken at the point of each rack.

In many machines having racks which are divided into a number of sections, the speed of each section, starting with the one nearest to the cylinder, is progressively increased. This causes a gradual thinning of the straw blanket and aids in tearing it apart. In the Minneapolis separator, having the three sets of racks each mounted at the rear of the multiple crank shaft, the speed increases in the ratio of one to three. That is, if we consider the speed of the first rack unity, the second will travel twice as fast and the third three times as fast as the first. At the junction point of each rack, the straw is greatly thinned and torn apart. This same idea is carried out in a number of machines and has been found to be a decided advantage in the matter of good separation. In other machines pickers working either by means of cranks in the top of the machine or set in a rotary frame as in the IXL picker used by the Avery

Manufacturing Company are used. These pickers supplement the action of the racks and tear all bunches of straw apart. We will shortly illustrate some of these devices.

The balancing of separators is an important consideration and is one that must be given careful thought in every well designed machine. If there are any heavy parts moving in a certain direction, or even light parts moving at a high rate of speed, these parts set up unbalanced forces that have a tendency to move the whole machine in the same direction unless their effect is counteracted by an equal mass moving in the opposite direction at the same time. When two or more racks are used, one may be used to counteract the effect of the other being made to travel in the opposite direction. Where only

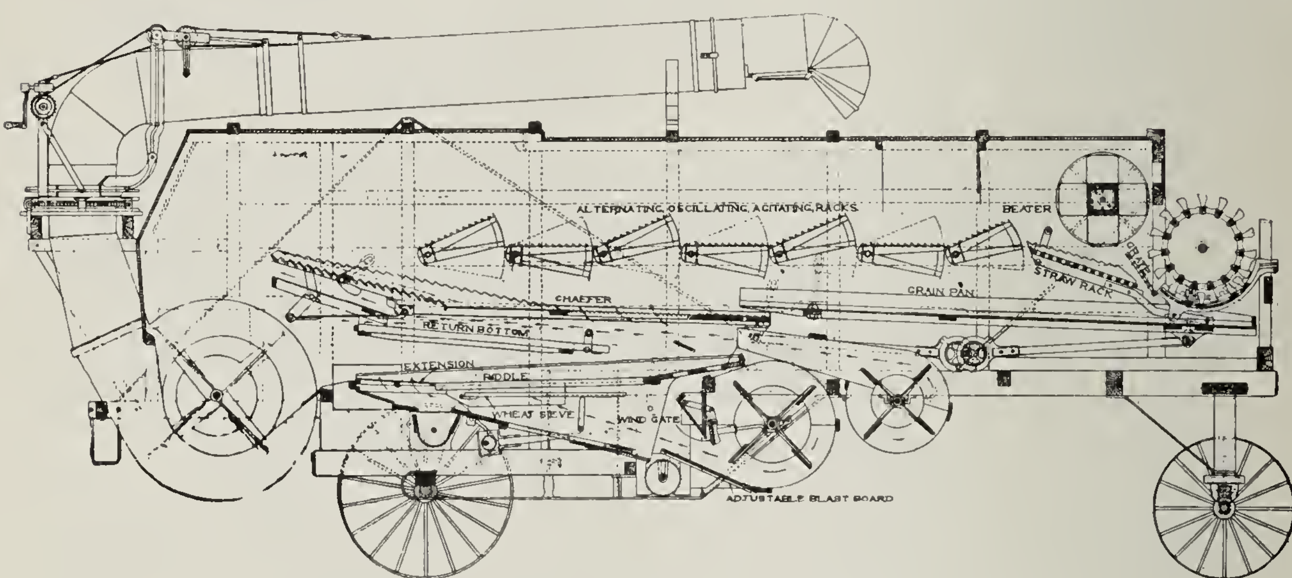


FIG. 20. SECTIONAL VIEW OF BAKER SEPARATOR.

a single long rack is used, balance is effected by making the grain pan vibrate in the opposite way. In rotary machines there is no such need because a rotary motion, when the rotating part has the same weight at all points around the circumference, has no tendency to cause oscillation of the whole machine.

The evil effects of vibration make themselves felt in a number of ways. In the first place it tends to shake the machine to pieces and causes loosening of all the joints. This causes either rusting or rotting at those points. It also causes a varying tension on the main drive belt, which causes irregular running of the whole machine, and this, of course, results in poor threshing. All of the machines are pretty well balanced for the speed at which they are supposed to run and it is interesting to take note of the manner in which this balancing has been accomplished. In any case, a machine is better that requires little if any balancing. Where an unbalanced force is set

up and this is counterbalanced by another force acting in the opposite direction, the starting and stopping of these masses must be taken up by some part of the frame work of the machine, with the result that there will be a continuous recurrence of strains at those points. The need for careful balancing also explains why all the moving parts of all these machines are made so light. It is a well known fact in mechanics, that the lighter a moving part is the less will be its momentum, and therefore it will have less capacity for disturbing the whole machine or of causing strain at any particular point.

We have already mentioned the matter of balancing separators and pointed out the importance of good balance of the entire machine. This begins, as previously stated, with the balancing of the cylinder and then extends to all other parts of the machine. Where reciprocating racks are made use of, as in most of the machines discussed, it is necessary to balance one against another, and proportion their weight and speed to each other with considerable exactness. If the work is carefully done the machine will be in balance when running at its normal speed when threshing, but not necessarily at a very slow speed or even at its normal speed when running empty. The reason for the better balance when loaded is found in the fact that the load is also in motion and adds just that much to the weight of the moving parts, and increases their momentum, all of which is taken into account by the designer. Unbalanced forces not only cause serious shocks to the machine, which do serious injury to the frame and bearings, but also cause the entire machine to rock back and forth on its wheels, thus stretching and slacking the main drive belt, and consequently disturbing the steadiness of running of every part of the whole machine.

Even pulleys require balancing, especially if they are required to run at high speed. All threshing machine pulleys are thus balanced by riveting a piece of metal on the under side of the rim on the light side. The amount of metal required for balancing and its proper location on the pulley rim are obtained in a very simple manner. Two straight edges, five or six feet long, are prepared and placed in a horizontal position both at the same level and a few inches apart. The pulley is mounted on a short shaft whose ends rest on the straight edges while the pulley is free to turn between. The pulley is then given a slight push and when it comes to rest a chalk mark is made on the upper side. This operation is repeated and if the same side stops uppermost it is evidence that is the light side. A lump of putty is then stuck on the under side of the rim and the operation is again repeated. After several trials the right amount of putty can be de-

termined. This is then weighed and an equal amount of iron is rivited in its place. A pulley that is not balanced runs with an unsteady motion and causes the shaft to hammer the bearings.

There is another class of machines which we have not yet considered, in which the problem of balancing is somewhat simplified, due to the reduction of the number of oscillating racks and the substitution of raddles or revolving belts which act as straw and chaff conveyors. These move at a relatively slow rate of speed and, furthermore, since the motion is a rotary one there is practically no vibration to contend with. There are only a few such machines now on the market although at an earlier date they were quite common.

In figure 21 we are showing a raddle machine made by the Gilbert Hunt Company, Walla Walla, Washington. The separation is ef-

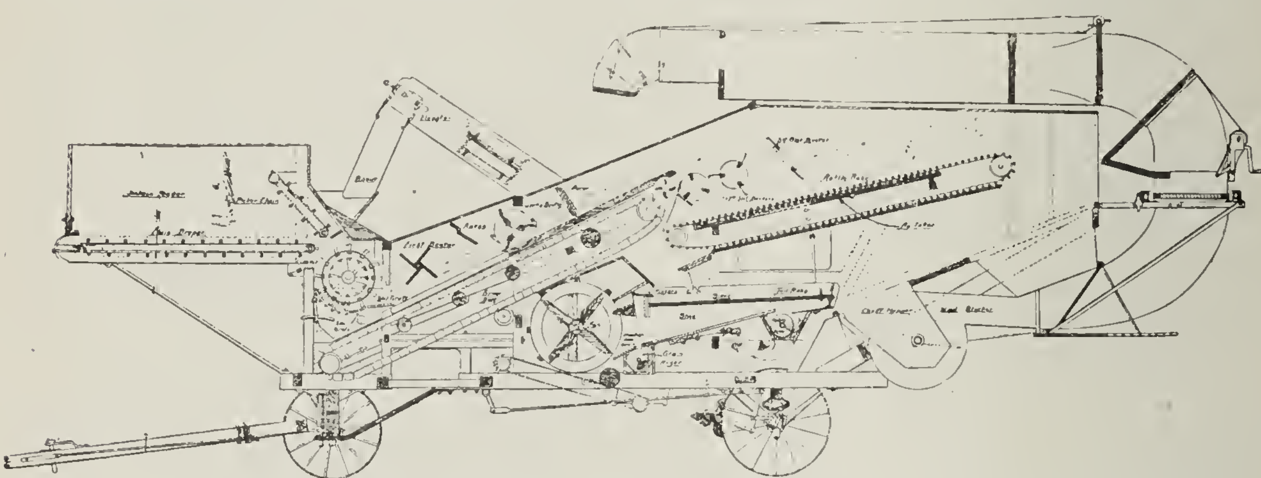


FIG. 21. THE HUNT SEPARATOR, SHOWING USE OF BEATERS, PICKERS AND RADDLES.

fected mainly by the use of beaters, pickers and the violent agitation given to the straw between the first and second raddles. The grain which falls upon the first raddle is carried upward in pockets or buckets in the conveyor belt which carries it to the rear of the machine, while other machines drop the grain on the grain pan and cause it to roll back to the shoe. The first mentioned method is said by the manufacturer to deliver the grain in a cleaner, better condition. This machine is used quite largely on the Pacific Coast and has given satisfaction. The fact that practically all the grain in that country is headed is a decided advantage to this type of machine. It is very well adapted to chaff and short straw but would probably meet with difficulty in handling large quantities of long, heavy straw such as is met with in the middle sections of the country. It might be stated in passing that this machine is the only thresher made in this country, so far as the writer has been able to learn, which makes use of the raddle idea exclusively.

Pickers, Beaters, etc.—An inspection of some of the illustrations on the succeeding pages will reveal the fact that a large number of machines make use of pickers and beaters, not only close to the cylinder, but at various points along the body of the machine. The object of these pickers is to tear the straw apart, and loosen the bunches of straw and otherwise agitate the mass as much as possible. In figure 21 these devices are depended upon to do practically all of the work of separation, but here the straw blanket consists in general of short straw and chaff. In some of the older threshers, pickers, worked by means of multiple cranks, are suspended from the upper part of the machine and constantly stir the straw. All of these devices are undoubtedly of value and are an aid in agitating the straw. We have no means of making comparison among all of these devices and can only present conditions as they exist. These devices were much more common on the older types of machines than they are at the present time. The growth of the industry seems to have proven that the vibrating rack alone is able to perform the work in a fairly satisfactory manner if properly designed.

We have now covered the different methods of separating devices used on the various machines, beginning with the cylinder and grates and proceeding to the rear of the machine. There is only one other device to be considered and that is the use of an auxiliary blast, after which we will proceed to a discussion of the grain pan, shoe, and cleaning devices.

CHAPTER V.

SEPARATOR DETAILS. THE SHOE, SIEVES AND FRAME WORK.

The upper straw racks have been pretty well discussed and all of the different types have been described and illustrated. All of the grain and chaff that fall through the upper racks fall upon the sieves or grain conveyor below and eventually reach the shoe. In some cases this load may be pretty heavy and several firms have made use at various times of an auxiliary fan to take care of a part of this load of chaff and prevent it from falling through. In the Buffalo-Pitts separator, illustrated in figure 22, we are showing a machine thus

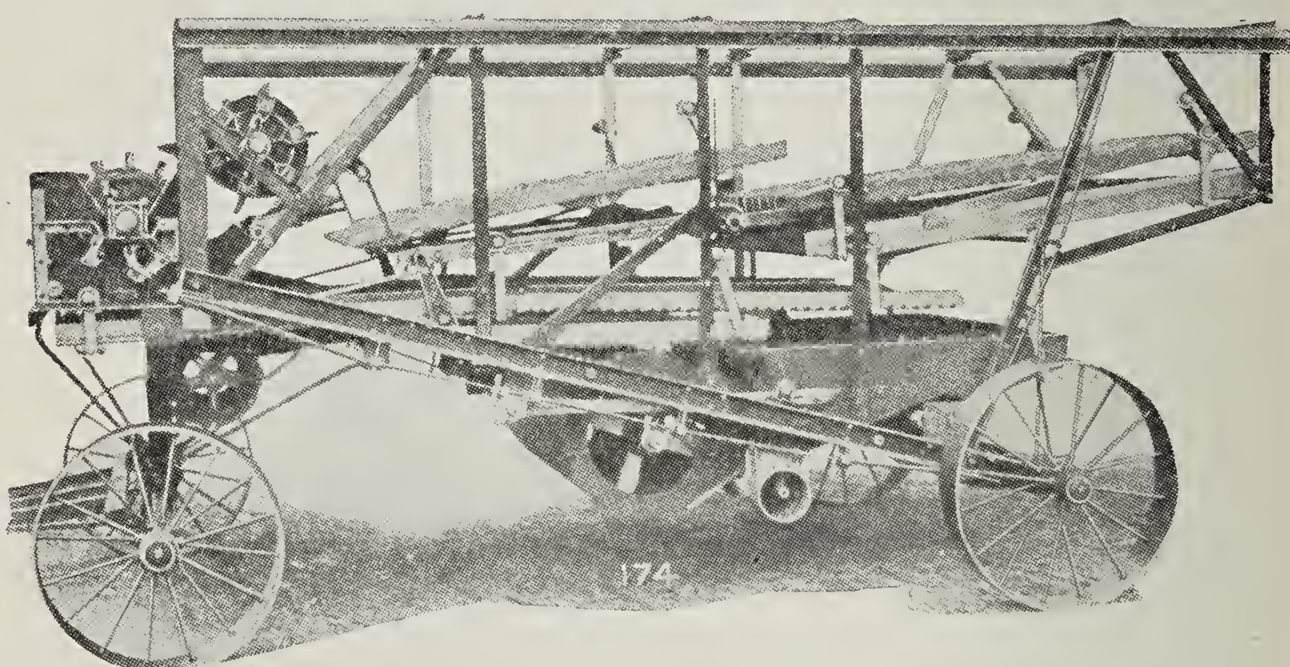


FIG. 22. FRAME WORK AND INTERNAL CONSTRUCTION OF BUFFALO-PITTS SEPARATOR. NOTE AUXILIARY FAN.

equipped. In this machine the fan is placed well toward the front of the machine and the blast is directed backward and toward the opening between the first and second straw racks. The idea is to catch the light stuff as it falls through and blow it back into the straw and thus relieve the cleaning devices of a part of the work. It must be remembered that as the blast of air leaves this fan it is slightly compressed and has a tendency to expand in every direction. This causes a slight blast of air to impinge upon the entire under side of the first straw rack, which has a tendency to prevent the chaff

from falling, as it passes over this rack, while at the same time it helps to project the chaff upon the rear rack where it is carried backward by the moving column of straw to the straw pile or blower as the case may be.

Another machine that makes use of this principle is the Advance Shaker machine. Here the auxiliary fan is placed close up to the opening between the first and second straw racks and the blast at that point is quite strong. In the new Advance machine this principle was dispensed with. Both of these machines have proven very successful in the severest service in the great wheat growing regions, but we do not presume to say how much of their success was due to the use of the auxiliary fan. We merely illustrate them to show another one of the many devices that have been and are still used on some of the best machines.

The grain pan or conveyor is located directly below the straw racks. It consists of a tight wood platform with slats every few inches over which the grain rolls on its way to the shoe where it is cleaned. This pan is given a short, quick back and forth motion by means of suitable link work. The sides of this pan are made grain tight by means of side pieces while at the front end of the machine a piece of strong canvas prevents any grain from sifting out at that point. The chaff and grain are propelled to the rear of the machine where they are dumped upon the shoe.

The shoe, so called, is nothing more or less than a fanning mill through which the grain is passed in order to clean it for market. The shoe proper contains the sieves and screens, while just in front and a little below is located the fan, which furnishes the necessary blast to do the cleaning. At the present time nearly all shoes are of the end shake type, that is, they are given a short back and forth motion of a few inches in the direction of the axis of the machine in order to agitate the grain and cause it to roll about on the sieves just as in an ordinary fanning mill. The exact amount of back and forth motions varies slightly in different machines and is generally made adjustable. The adjustment is accomplished by changing the pivotal point of the bell crank hanger which gives the motion. Two or three holes are provided to accommodate the necessary adjustments. About four or five inches of shake is the maximum provided for and this amount is necessary only in damp, heavy grain, where very violent motion is necessary in order to give it sufficient motion on the shoe.

The majority of separators are equipped with end shake shoes, but there are a few good machines which still use side shake shoes. The amount of side shake is slight but it is enough to agitate the grain

on the sieves. There are also several machines in which the shoe is stationary, that is, it has no motion at all. The sieveless machines are of this class. These have proven to give the best satisfaction generally and adapt themselves easily to a more perfect balance of the whole structure because all motion of a vibratory character is in the same general direction.

In figure 23 we are showing a view of the Avery shoe and fan, which gives a very good illustration of the general disposition of all the various parts. In this mill an over blast fan is used, that is, one in which the top of the fan tips travels towards the shoe. Some machines are built using an under blast fan. Both kinds are common and give about equal results when properly placed in relation to

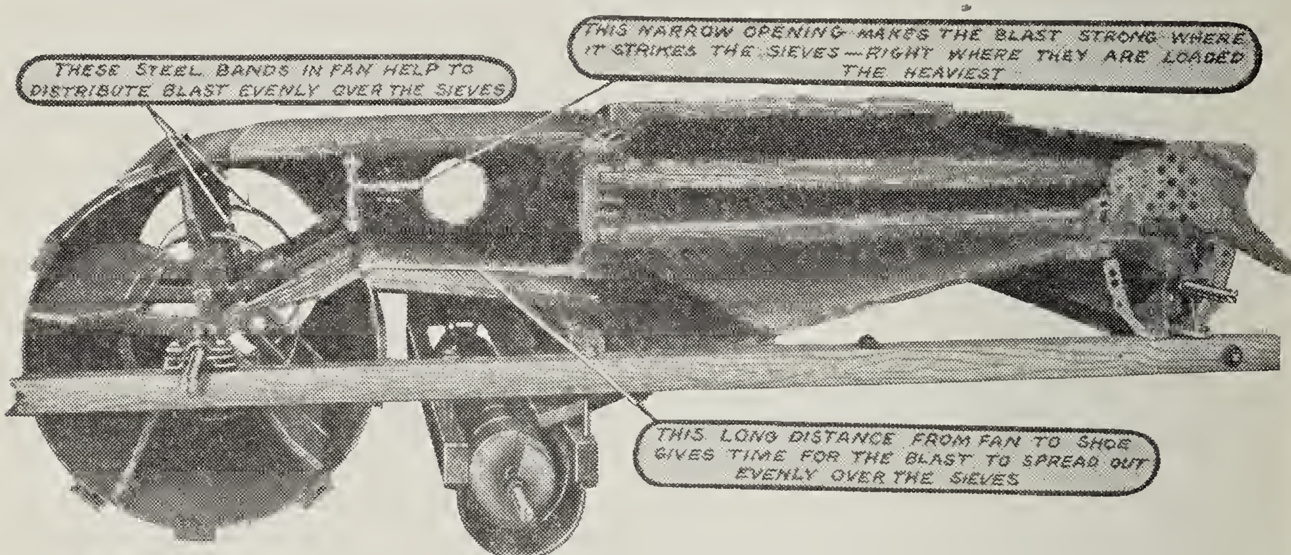


FIG. 23. OVER BLAST FAN AND THE SHOE OF AVERY SEPARATOR.

the other parts. We will reserve the full discussion of fans for a later consideration and proceed now to examine the grain conveyor and shoe more carefully. At the rear end of the grain conveyor and forming a part of it, we find the chaffer. This is located just above the shoe and consists in some cases of open wooden slat work, but in most modern machines of a coarse lipped adjustable sheet metal sieve, whose amount of opening may be adjusted while the machine is running, to best meet the conditions of the grain. The function of the chaffer is to separate the sticks and coarse stuff from the grain and fine chaff and prevent it from reaching the sieves. This coarse material is cast back to the rear of the machine and mingles with the straw, while the good grain and some chaff drop through to the shoe. Back of the chaffer and forming a part of it is a set of fingers called the chaffer extension, while just below is located the tailings auger at the bottom of a set of hopper over which these fingers extend well toward the rear side. Any unthreshed heads or chaff containing

grain, being heavier than the chaff, is supposed to fall through these fingers and be returned by means of the tailings auger and tailings elevator back to the cylinder to be rethreshed. There will also be some unthreshed heads which pass through the chaffer upon the sieves and these will be carried by the blast back to the tailings auger and thence to the cylinder. The amount and the character of the tailings is a good indication of the work the chaffer and sieves are doing. The tailings should be small in amount and contain only a small amount of chaff and little plump grain. In case any unthreshed heads are returned it is evident the cylinder is not doing its work properly. Either the spacing of teeth between the cylinder and concaves may be wrong or the concaves need raising. If too much good grain appears in the tailings the operator should determine if it comes over the shoe sieve to the tailings auger or through the conveyor extension. If it comes by the latter route the conveyor sieve should be opened a slight amount to give the grain a better chance to fall through. In general, an angle of about forty-five degrees will be found most satisfactory. On the other hand, if the grain is coming over the shoe sieve the probabilities are that the conveyor sieve is open too wide and that the shoe sieve is loaded so heavily that it cannot take care of the burden. The remedy, of course, is to close the opening in the chaffer slightly and not let so much chaff through. If a great deal of short straw is found on the sieves and in the tailings, relief may be obtained by taking out some of the concaves. Grain which is returned with the tailings is liable to be cracked by the cylinder on rethreshing which, if the tailings are heavy, may be of more than passing importance. In any event, the tailings should be light, as they represent half done work in the first place and when heavy are an unmistakable evidence of faulty adjustment at some point.

Fans for producing the blast are of two kinds known as over blast and under blast fans, depending upon their direction of rotation. If the top of the fan travels toward the sieves it is called an over blast fan, if in the opposite direction it is called an under blast fan. Both types of fans are widely used and both perform the same functions about equally well. The principal thing is to obtain the correct intensity of blast for the work it has to do. This work is the lifting of the chaff, straw, dust and other light material slightly above the sieves and projecting it back to mingle with the straw at the rear end of the machine. None of this light material should drop through and mingle with the grain which is delivered to the grain auger. Neither should the blast be so strong as to throw any of the unthreshed heads beyond the chaffer extension and into the straw. When properly

handled the blast will keep all of the material which falls on the sieves thoroughly agitated, in a loose fluffy condition and moving back slowly toward the rear. The heavier grain falls through this mass to the sieve and the lighter portions move back barely in contact with sieves or chaffer. The unthreshed heads should fall through the chaffer extension and be caught by the tailings auger. When the grain is very dry and brittle the blast should be stronger to take care of the heavy burden on the sieves. This burden, however, as indicated on a previous page, can be relieved somewhat by removing all but two rows of concave teeth.

There is some difference between the effects of the speed of the blast and its volume. A thin blast, that is, with a relatively small quantity of air and high speed, is apt to throw grain into the straw, while a slower blast with greater volume will move the lighter portions surely but gently and makes for better separation. It is the duty of the operator to look after the blast very closely since so much depends upon its proper manipulation. The intensity or amount of the blast is regulated by the amount of opening of the wind gates on the sides of the fan housing. If these are wide open the volume of air passing through the sieves will be larger than if they were only partly opened, consequently with a heavy burden on the sieves they should be opened wider.

Another matter the operator must watch carefully is the direction of the blast upon the sieves. The air should strike the sieves in equal intensity and amount at all points from side to side of the machine. In other words, it should be distributed evenly across the width of the sieves and no more should pass through on one side than on the other, because if this occurs the part of the sieve getting insufficient air will allow dirt to fall through into the grain, while on the other side grain may be thrown over into the straw, and the machine will work very badly, presenting a curious condition of poor cleaning and yet of throwing over grain.

This condition is liable to occur in the case of a strong side wind if the blast gates are not properly handled. A strong wind from one side has a tendency to force the greater part of the air to the opposite side of the machine and leave one side of the sieves insufficiently supplied. The remedy is, of course, to close partially or wholly, according to circumstances, the wind gates on the windward side of the machine.

Another thing which affects the load on the sieves and also the distribution of the air is the inclination of the machine sidewise. If not set level the grain and chaff will gravitate toward the lower side, thus overloading one side of the sieves and leaving the other side

nearly bare. Under such conditions it is almost impossible to adjust the blast. Care should be taken to level the machine sidewise before beginning threshing. Leveling lengthwise is not so important. Indeed, some operators always set the rear of the machine a few inches lower than the front and claim to obtain better results. There is no objection to the custom. In fact, the writer knows of many cases where it has shown improved results, due to the fact that the grain was retarded less by gravity in moving back from the front end of the machine, and to the better angle at which the blast imginged upon the sieves.

The point at which the blast strikes the sieves and the angle at which it strikes are both important. The blast should strike at a point about half way back on the sieves and at such an angle that it keeps the chaff lifted well from them, but without driving it backward out of the machine with too great force. The blast will, necessarily, be stronger in the meshes of the sieve than a short distance above, because the openings represent only about seven-twelfths of the area of the sieve. All of the air must pass through this restricted area and hence must have higher velocity in the meshes than just above the sieves. This is as it should be. It keeps the meshes clear and the blast is strongest at the place it can do the most good. The direction of the blast is controlled by the wind board or boards which can be turned to direct the air at the desired angle and position upon the sieves.

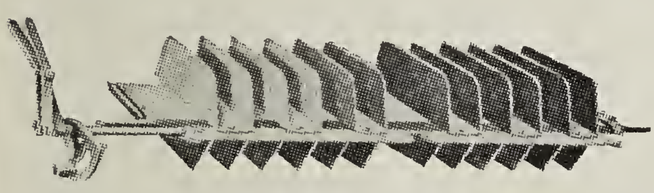


FIG. 24. THE REEVES AIR DISTRIBUTING GUIDES.

In some machines special devices for distributing the wind are shown, the idea being to spread it evenly over the sieves as well as to direct it at the proper angle. Figure 24 shows the wind controlling device used by Reeves & Co. The metal deflectors may be set at any desired angle by means of levers on the side of the machine. The Avery Company claim to obtain better distribution of the air and less tendency for the greatest discharge to take place at the middle of the fan by means of metal bands placed a short distance in from the ends of the fan.

Some machines are provided with an automatic blast regulator or governor which regulates the volume of the blast in accordance with what it has to do. There seems good reason for a device of this sort for the reason that when the machine is heavily loaded a much stronger blast is needed than when it is running almost empty. A regulator that is sensitive enough to take care of these variations

in the load ought to do some good. Otherwise the good operator is careful to see that the feeding is done as uniformly as possible and instructs his pitchers to that effect.

Sieves and Screens.—Sieves are distinguished from screens by the fact that grain passes *through* sieves and *over* screens. The object of a sieve is to assist the fan or blast to remove all straw, chaff, sticks and other large stuff from the grain. The object of the screen is to remove the small stuff such as weed seeds, sand and dirt from the grain. The sieves are placed in the upper part of the shoe and the screens in the lower part. There are two kinds of sieves, the common and the adjustable. Common sieves are made either of woven wire or of sheet metal. Those made of sheet metal are perforated with either round or oblong holes depending upon the grain they are intended to clean. For clover seed, timothy, flax and sometimes wheat, round hole sieves are used, while peas and orchard grass sieves have oblong holes. Then there is another style of sieve commonly used known as lipped sieves used for wheat, oats, rye and barley.

The adjustable sieve has been introduced within the past few years and will eventually displace most of the common sieves. It is readily adjustable for different kinds of grain by means of a lever on the outside of the machine. The adjustment can be made while the machine is running and tried gradually until the exact opening is found to give best results. The adjustable chaffer with adjustable sieves makes a good combination. Screens are also made with either round holes or oblong holes. Except where there is much weed seed or dirt in the grain, screens are not generally used because of the fact that they obstruct the blast and become easily clogged. When used they should be watched carefully. For most weed seeds the round hole screen is best but for wheat the oblong screen is the only form that will work satisfactorily.

It is not an easy matter to explain how to set the sieves for threshing the different kinds of grain under all the different conditions that are to be met with in the field. Besides, there is often more than one way to obtain good results. About the best thing to do is to give general directions, then if the operator will study the principles of grain threshing and separation he can reason out what is the best thing to do under any given condition.

On various occasions we have pointed out what is the proper thing to do under given conditions, but we will now repeat some of these directions in order to bring them all together. To begin with, there is the number of rows of concave teeth to be considered. A general rule is to use as few as possible and yet do good work. In dry grain fewer may be used than when the grain is damp. For wheat it is

generally sufficient to use only four rows of concave teeth. Most operators prefer to place two rows well toward the back, then put in a blank and then two more rows. This arrangement will generally be found satisfactory with any of the ordinary varieties of wheat. When threshing Turkey Red wheat or Durum wheat it is often necessary to use six rows of teeth because these wheats are much more difficult to thresh. If many unthreshed heads pass through it is well to see that the concaves are raised as high as they will go. Where the wheat is easy to thresh it is not necessary to use so many rows of teeth nor to raise the concaves. In fact, under these conditions fewer teeth will entail a lighter burden on the sieves and make for better cleaning. Another thing to be carefully looked after is the condition of all of the teeth. Teeth that are badly worn or bent will allow unthreshed heads to pass through. The spacing of the teeth is also important.

For dry grain it is not necessary to run the machine quite up to the speed printed on the front of the machine, but if the grain is a little tough then full speed must be maintained and sometimes a little exceeded. When the adjustable shoe sieve is used it should be placed in the top of the shoe at the fan end and three or four holes down on the other end. In general this will give the best angle for the blast. If the grain is damp it may be necessary to raise it at the rear end and lower the fan end a little in order to use a stronger blast and still prevent the blowing over of the grain.

If common sieves are used it is better to use the largest lipped sieve for the chaffer and the medium lipped sieve for the first sieve in the shoe. A quarter-inch round hole sieve will be found best for removing white-caps. If there is much cockle in the wheat a special cockle sieve may be used. This is a round hole sieve with openings about five thirty-seconds of an inch in diameter.

In threshing headed grain more concave teeth are needed than in in threshing grain with the straw attached, because of the fact that when there is long straw it is fed into the cylinder heads first and the straw is held by the feeder while the grain is beaten out of the heads. With headed grain there is a tendency for it to pass through much quicker and unless everything is in good shape some of it is liable not to be threshed.

In all threshing the action of the machine can be pretty accurately determined by the character and amount of the tailings. These should be light and show only a small amount of unthreshed grain. If the tailings elevator is overloaded it indicates poor work at the cylinder. Obviously the thing to do is to see if the concaves are set up as far as they should be, if there are enough rows of concaves in place, and if the teeth are in good condition.

Rye is not difficult to thresh. In fact, it is easily separated from the heads. The greatest trouble experienced is with the straw, which has a tendency to wind, being somewhat tough. This is more especially true if it happens to be a trifle damp or has sweated in the stack. The best remedy is to use only a few rows of concave teeth and to run the machine at a higher rate of speed than for wheat threshing. This has a tendency to prevent winding. Sometimes rye can be threshed without any concave teeth at all. The same sieves should be used as in threshing wheat and they should be placed in the same manner.

Oats are easily threshed when dry. Usually two rows of concave teeth are all that are required. When in good condition it is possible with one of the large separators to thresh as high as seven hundred bushels an hour. Of course, to make a record like this the yield must be very high, that is, there should be a large amount of grain in the straw. When oats are damp or a trifle green the straw is apt to wind and then it is necessary to run the machine at a higher rate of speed. From what has been said it will be seen that in general the remedy for winding is a high rate of speed for the machine. The adjustable sieves should be set more open for oats than for wheat or rye. This is necessary because of the fact that oats being only about half as heavy as wheat do not require as high a velocity of the blast in the openings of the sieves as does wheat. For the same reason it is not necessary to use quite as strong a blast for oats as for wheat threshing. Care must be taken not to blow grain over into the straw. In threshing light oats, that is, oats that are poorly filled, the hulls will be blown out and the customer is apt to find considerable fault. The only thing to do is to be careful and show him that there is no meat in the hulls. It is impossible to save the worthless hulls. The same screens that are used in threshing wheat may be used in threshing and cleaning oats if desired, but generally no screens at all are used.

The position of the sieves in the shoe differs slightly in different machines and no general rule can be given. The best thing to do is to start with the directions as given in the book of directions sent out with the machine and then vary them as common sense and experience dictate if the work is not entirely satisfactory.

Barley is harder to thresh than oats owing to the fact that the beards are sometimes difficult to separate from the heads if the grain is a trifle damp. The machine should be run at a high rate of speed if the barley is a trifle damp, that is, at or a little above the rated speed. It also takes a full set of concave teeth and they should be set up quite close. The sieves should be set high in the rear and low in front as in all kinds of difficult cleaning. This arrangement al-

lows a better angle for the blast to strike the sieves. This also accounts for the custom of some operators of setting the rear of the machine a little lower than the front end. However, the writer once found a condition in threshing green barley where the grain was blown badly into the stack, that better work was done by setting the sieves almost level. Here was a case where the machine had to be run very fast in order to thresh the grain out of the heads and the blast was very strong, thus throwing over quite a good deal of grain. By making the change indicated, the speed could be maintained and yet the angle of blast was changed in such a way that none of the grain was thrown out. This little incident merely adds force to the statement that no general rules can be given. The operator should study conditions carefully and get a thorough understanding of all of the principles and then he is in a position to reason out what to do in any particular case.

The threshing of flax presents some unusual difficulties on account of the fact that the flax straw is very tough on account of the tow. It has a tendency to wind wherever there is a part of the machine upon which it can wind. The only remedy for this condition is full speed just as in the case of rye or oat straw. If a little green, it will require the full complement of six rows of concave teeth to thresh the grain out of the bolls. In some cases the cleaning can be done effectively with only adjustable sieves but generally it will be necessary to use a special flax sieve below. This special sieve is a round hole sieve with holes about an eighth or five thirty-seconds of an inch in diameter. Care must be taken in feeding flax to the machine. It is usually fed loose, that is, unbound, and it should be fed evenly and not in bunches that will slug the machine—if good work is desired. Where two or more sieves are used the blast can be stronger than where only one is used as it requires more pressure to get the air through the sieves.

In threshing flax as in threshing all the different grains it is necessary to look well after the speed of all parts of the machine. If the straw begins to clog the racks, the trouble is almost invariably due to a loose belt which does not drive the racks at their regulation speed. In a nice running machine all the belts must be kept in good condition or some part of the work will be poorly done. This makes it necessary for the operator to go over the belts carefully every day and make sure that all of them are not only well laced and in good condition but that they are at the right tension to transmit the correct speed. Everything depends upon the speed of the different parts and the speed of each part is nicely adjusted to the speed of every other part.

On the preceding pages I have dwelt at some length on the matter of speed at which the cylinder should be run. What has been said applies to the conditions mentioned, but perhaps a little further discussion of this rather important subject may not be without interest. In considering the size of the grain threshed we find as a general rule that the larger the grain the slower we must run the cylinder in order to do satisfactory work. For example, in threshing peas or beans if we should run the machine at the usual speed employed in threshing the smaller grains damage would be done to the grain itself. Much of it would be cracked and rendered worthless or nearly so for the market. The same rule applies to the larger varieties of wheat. This is especially true if the wheat is very dry. West of the mountains where the wheat is very dry and the kernels large, it is necessary to run the cylinder considerably slower than the speed employed in localities east of the mountains in order to prevent cracking the grain. In fact, it would be well to have the cylinders of the machines that go into that territory speeded a little slower than they are for the middle sections of the country where the grain is always somewhat damp, due to climatic conditions.

The speeds of the different parts of the machine are very important and the careful operator will be careful to watch and make sure that every part is running at normal speed. An accurate speed indicator is therefore very essential, for by its use it is easy to tell in a moment if any pulley is running too slow. By its use one can tell if a belt is slipping and just how much. It is a very good plan to figure out, once for all, just how fast each of the different pulleys should run and mark the speed on the side of the machine for future reference. A great deal of the trouble experienced with separators is due to the slipping of some of the belts and often the operator does not know which belt is at fault.

And right here I want to give our readers a little advice in regard to the care of belts. Go all over the machine twice every day, once in the morning and once again at noon time, and make sure that every belt is laced properly and in fit condition to go through until the next inspection time. There is very little excuse for being obliged to stop the separator to make repairs to the belts, racks, or any other parts unless it be the cylinder teeth. These, of course, are liable to injury through sticks or stones that may accidentally go through the machine unbeknown to the separator man. Close attention to detail and a never ending vigilance are the necessary qualifications of a good separator man. If the understands his business the work is not hard. It is, in fact, easier than the engineer's job, though a little dirtier. There are probably fewer good separator men

than good engineers. Many young fellows seem to think there is a certain sort of glory or distinction in being an engineer, but not in being a separator man. This is where they make a mistake, however, for it requires just as careful thinking and just as good mechanical ability to be a good separator man as it does to be a good engineer. There are few rules to work by in handling a separator and every new condition is almost a new problem, which must be solved and solved quickly and correctly. There are many men running separators who get along in an indifferent manner but who do not really do good work. They do not get the maximum efficiency out of the machine; either it does not thresh as fast as it should or it wastes grain, or it does not clean the grain as well as it should. One should not be satisfied with his work until he knows no one can possibly do better with the machine than he is doing.

Fast threshing, clean grain and no waste; this should be the separator man's motto. Until he can live up to this motto he is not a real separator man.

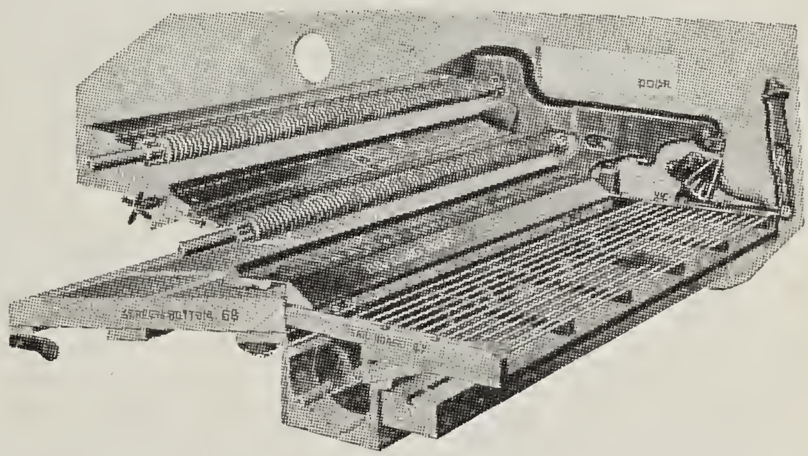


FIG. 25. COMBS AND ROLLERS USED IN PLACE OF SIEVES IN GEISER SEPARATOR.

At least two companies, the Geiser and the Frick, build what are known as sieveless separators. Instead of using sieves they make use of revolving grooved rollers and combs, over which the grain passes while at the same time it is being acted upon by the blast. Before the grain reaches the first roller, which has zigzag U shaped grooves, it passes first over a short vibrating bottom which carries it to the roller A large part of the grain will pass down on the inside of the roller through the grooves. The coarse stuff and some of the grain will be carried over and fall upon a narrow shelf. Between this shelf and the first roller a blast of air passes which does two things: it prevents any chaff from falling and projects the lighter, coarser particles to the rear of the machine. The grain falls upon this shelf in a cone shaped ridge, with comparatively clean grain on the front side of the ridge that continually falls through the blast to the grain spout below, while the rear side of the ridge is covered with unthreshed heads and coarse heavy stuff that does not readily respond to the influence of the blast. Below this shelf there is another roller, as can be seen by referring to the accompanying illustration, figure 25. This roller is also grooved

and a blast of air passes up on each side of it. Below this there is another shelf upon which the grain falls and the same operation is repeated that has been explained for the first roller and shelf. After the grain falls upon the lower shelf, it passes over a short toothed comb which is attached to the rear side of this shelf which allows all all of the rest of the grain to fall through. All of the coarse stuff, unthreshed heads, etc., now passes over the comb and drops upon a narrow vibrating rack located above the tailings spout. The heavy large stuff is carried back while the unthreshed heads drop into the tailings and are carried back to the cylinder. Wheat, oats, barley and grain of that character can be threshed and cleaned with this device by merely making some trifling adjustments, but when it comes to the threshing of flax, timothy or some of the other small grains it is necessary to use a special attachment consisting of two sieves. With this change the machine will do excellent cleaning of any of the grains. Another feature of this machine which differs from any of the others is the automatic blast regulating device shown in figure 26. With this arrangement a blast of practically uniform intensity is said to be maintained, which aids greatly in doing clean work. The foregoing description applies particularly to the Geiser separator, but the explanation of the action of the grooved rollers and combs applies just the same to the Frick machine.

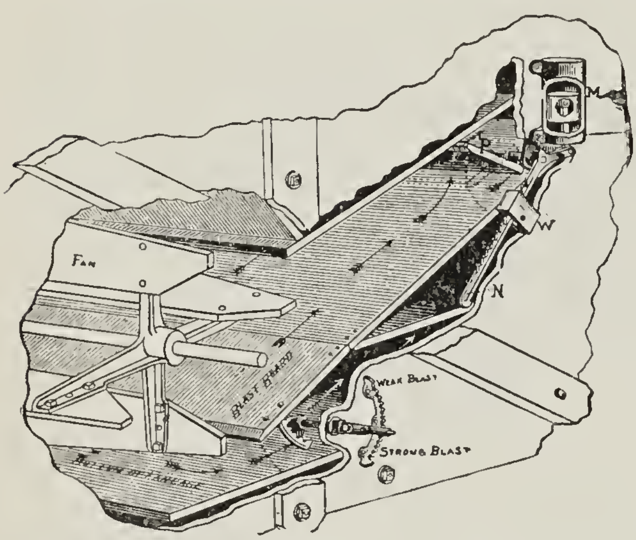


FIG. 26. AUTOMATIC BLAST REGULATOR OF GEISER SEPARATOR.

The Frame.—Logically the frame work of the separator should probably have been discussed first, but for obvious reasons it has been deferred until the present. At the present time there are two distinct styles of frames, one made of wood, the other of steel. The steel frame with steel sides is a comparatively new type which has been brought out within the past very few years. It has certain advantages such as rigidity and less liability to catch fire than the old wooden frame machines. However, the greater number of separators are still built of wood and these give excellent service when properly made and taken care of.

Figure 27 shows one of the forms of framing that is employed. The bed pieces are made of very heavy timbers solidly bolted together

and reinforced with angle irons and through bolts where the greatest strains occur. Steel tie rods run through the frame from end to end and materially increase the strength of the frame. A separator of one of the larger sizes complete weighs between eighty-five hundred and ten thousand pounds. It is large and unwieldy and higher above the trucks than it should be to be perfectly rigid. This, of course, can not be helped, hence the necessity of making it exceedingly strong to withstand the strains of rough roads. A simple mortise and tennon joint is not sufficient no matter how well made where the heavy

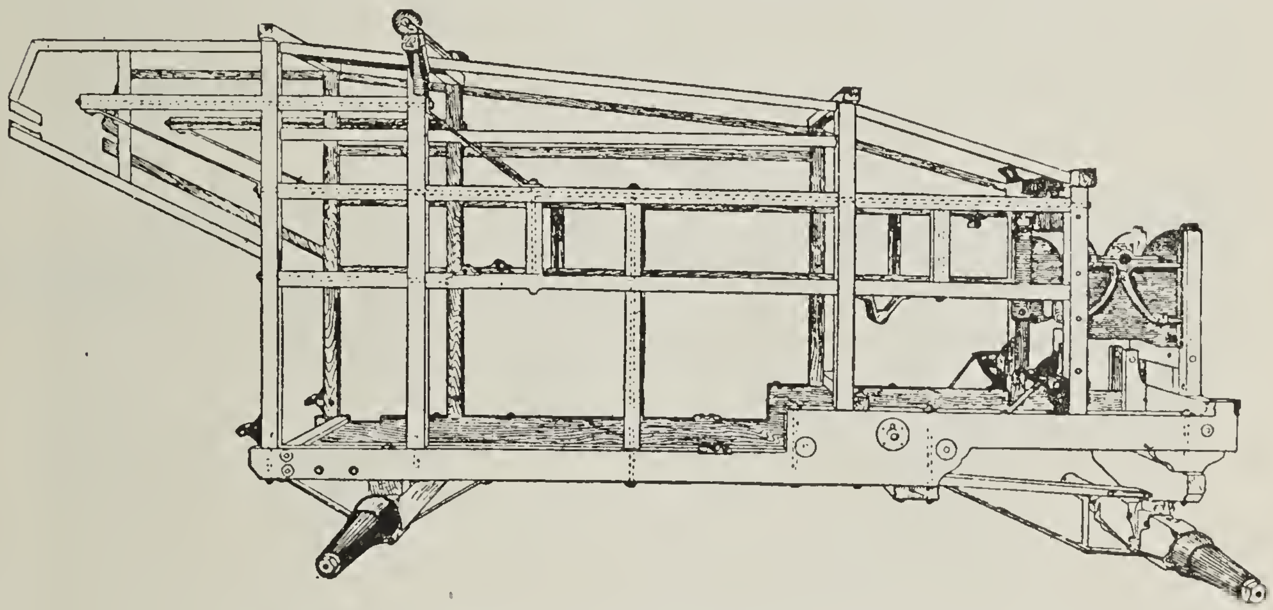


FIG. 27. FRAME WORK OF SEPARATOR BUILT BY NORTHWEST THRESHER COMPANY.

strains occur. At these points it is necessary to use through tie rods, angle irons or heavy castings to prevent working at the joints. No matter how well a separator frame may be put together there will be some working at the joints unless they are secured very solidly by proper reinforcement. When the joints begin to work they soon wear loose and then the whole machine is out of line. Furthermore, moisture works into the joints and causes decay.

Paint is one of the best wood preservatives and the man who wants to keep his machine in good condition will be careful to keep it well painted, especially around the joints. Then if he is careful not to run his machine out of level and takes care to travel at a moderate speed over the roads, and especially the rough roads, he ought to be able to make his machine last a good many years.

It is not an easy matter to design a separator frame which will be substantially braced and which at the same time will be clear and free at all points for the placing of the racks and other moving parts and for the passage of the straw. In all framed structures the com-

pleted edifice is composed of a series of triangles, since this is the only figure that will maintain its form and combine the maximum strength with the use of the least material under any system of loading. As evidence of the truth of this statement, it is only necessary to call attention to the fact that all bridge and roof trusses are built up of a series of triangles disposed in such a manner that every member is either in straight tension or compression and with no bending or shearing stresses in any member except in the lower chord.

A separator frame built in the same manner as a bridge would have maximum strength and would hold its shape almost indefinitely. This ideal is hard to realize, however, in practice, on account of the fact that we have to deal with a box-like structure which is subjected to

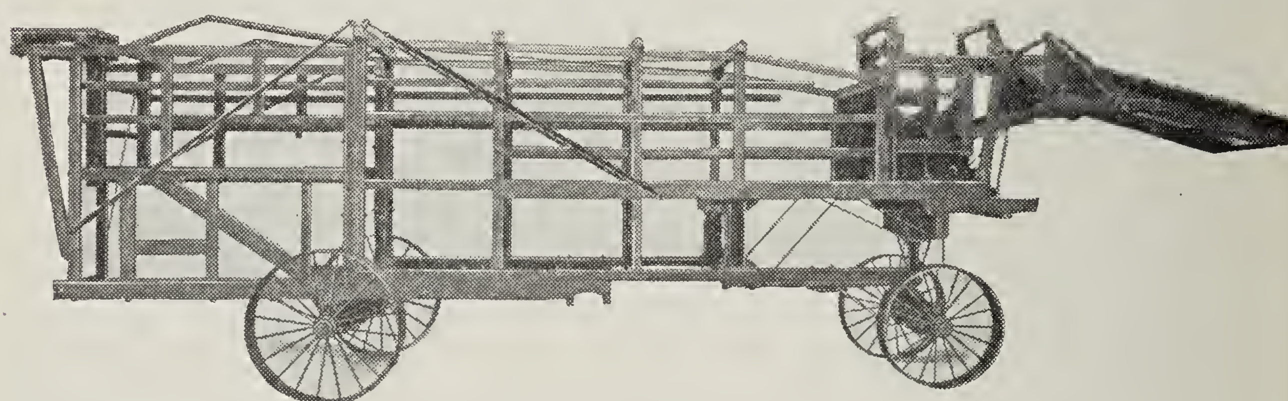


FIG. 28. FRAME WORK OF AVERY SEPARATOR.

lateral stresses as well as to vertical stresses and it is impossible to make use of cross braces running from corner to corner through the middle of the machine. This necessitates using rather heavy bed pieces and both through rods and angle irons at the corners. All of these, when properly disposed, will keep the frame in very good shape and thus prevent the working parts from getting badly out of line, but in order to obtain such satisfactory results the designers are obliged to exercise exceptional care and good judgment.

Figures 28 to 31 inclusive show how different designers have attacked the problem and the solution they arrived at. These views, unfortunately, do not show anything but the side frame, leaving the members out that tie the two sides of the machine together. These, however, consist in every case of strong cross pieces attached by bolts and mortised to the side frame, with usually angle braces at the corners of the bottom member.

The front axle of the machine is attached by means of a pivot bearing while the rear axle is bolted rigidly to the framework, thus providing three points of support just as in all other road vehicles.

The stresses on the framework of a separator are occasioned by

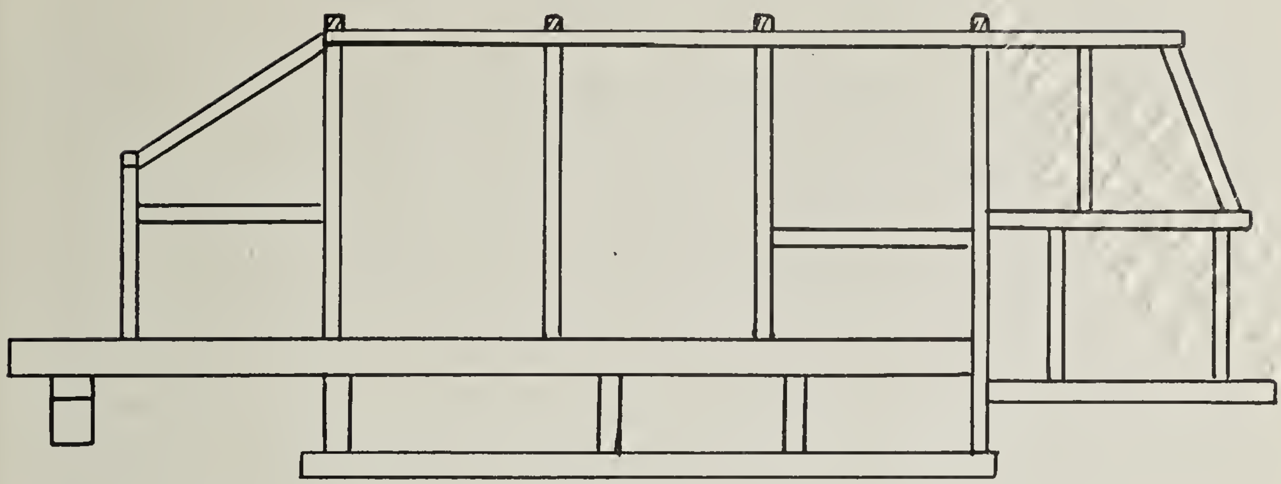


FIG. 29.

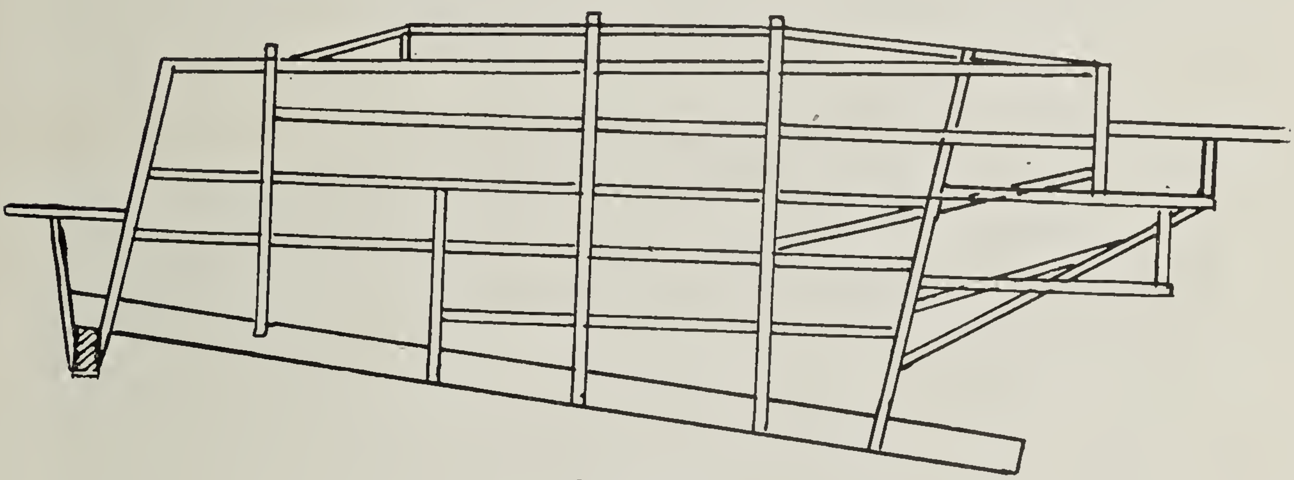
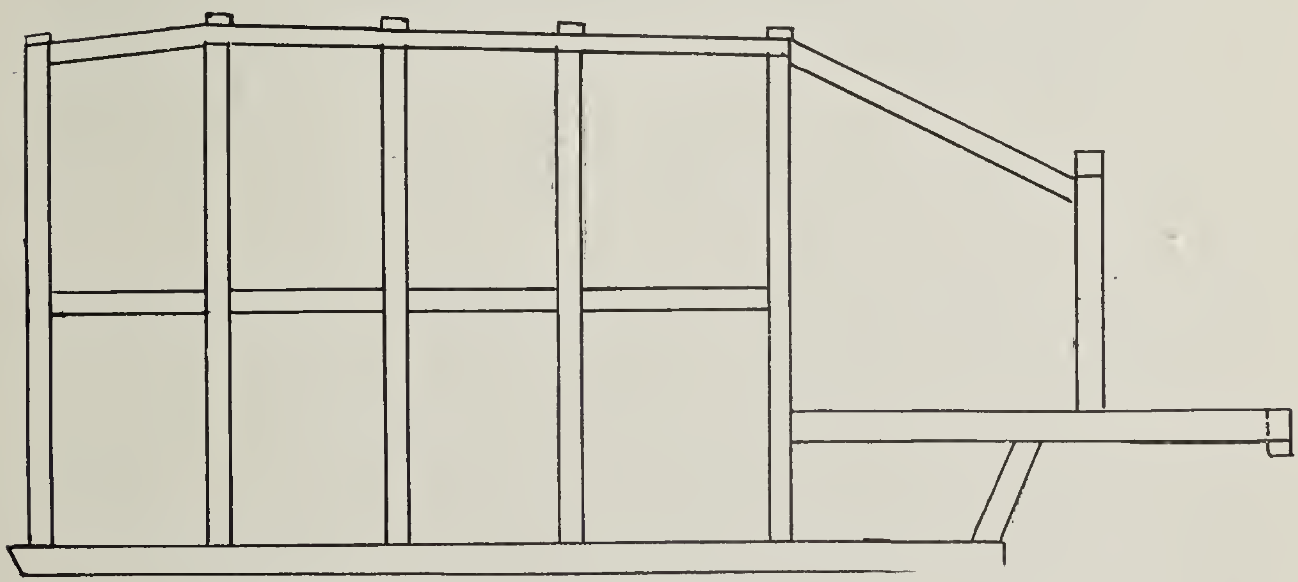


FIG. 30.



Iron braces at all corners

FIG. 31.

GROUP SHOWING DIFFERENT STYLES OF FRAME DESIGN.

rough roads, by transmitting power through belts from one pulley to another, and by the natural vibration of the machine out of level. The first of these strains, that due to rough roads, is perhaps the most severe, since the lurching of the machine sidewise causes heavy lateral strains which the machine is least able to bear without distortion. These strains increase rapidly with fast road speeds, especially if the roads are a little rough. In all cases they can be greatly minimized by rather slow, careful driving.

The normal working strains being in the direction of the bed pieces and main frame, in most cases, are not very severe and are unavoidable. They can be reduced to a minimum by running the machine at the correct speed and keeping all belts at the right tension. The wear and tear due to the natural vibration of the machine tends to disturb the adjustment of its parts and makes it necessary for the operator to keep careful watch lest nuts shake loose, or any vital part of the machine becomes misplaced.

Running with the machine out of level is another fruitful source of trouble, since it throws the weight of grain to one side of the machine and loads the bearings on the lower side of the machine. A separator is a complicated machine; there are a large number of parts to keep in adjustment and it requires good judgment and great carefulness on the part of the operator to keep everything running smoothly. The operator should be a close observer and should make careful inspection of his machine every time it is stopped. When it is running he should go over it frequently also, watch the bearings to see they are not heating, note whether or not all pulleys are running at the proper speed, and judge by the sound the machine makes if it is running right. It takes a cool, level headed man with good judgment to be a first rate separator man, for, in addition to understanding thoroughly the principles of separation in all the various kinds and conditions of grain, he must be a good mill man or mechanician.

The life of a separator is not easy to estimate. In Minnesota and the Dakotas between four and five years is considered the average time a separator will last. Even there, however, it is not uncommon to find machines from ten to fifteen years old which have seen service every season and are still doing good work. It would seem, therefore, barring possible accidents, that separators should be made to last ten years on an average if handled by careful, competent operators.

Many separators are injured more in the first few hours of operation than in a normal season's run because of lack of care in putting everything in first class shape. Here is a place where it truly pays to make haste slowly.

After a long journey by rail the bearings are generally full of cinders and need cleaning. The writer remembers going once to repair a new machine that had run only a couple of hours and found the blower boxes melted out because the operator had neglected to clean out the cinders. Here was an accident that there was no excuse for whatever. Some things are hard to foresee but it is not hard to realize that the bearings of any machine need attention if the machine has traveled on an open flat car several hundred miles. Another instance of carelessness which could not be condoned was the melting out of the main cylinder boxes on another machine because of an over tight drive belt. In still another machine the jaws that held the weigher to its support on the top of the machine did not fit exactly right and the feeder fell off, of course doing considerable damage to certain of its parts. Here was another case of incom-

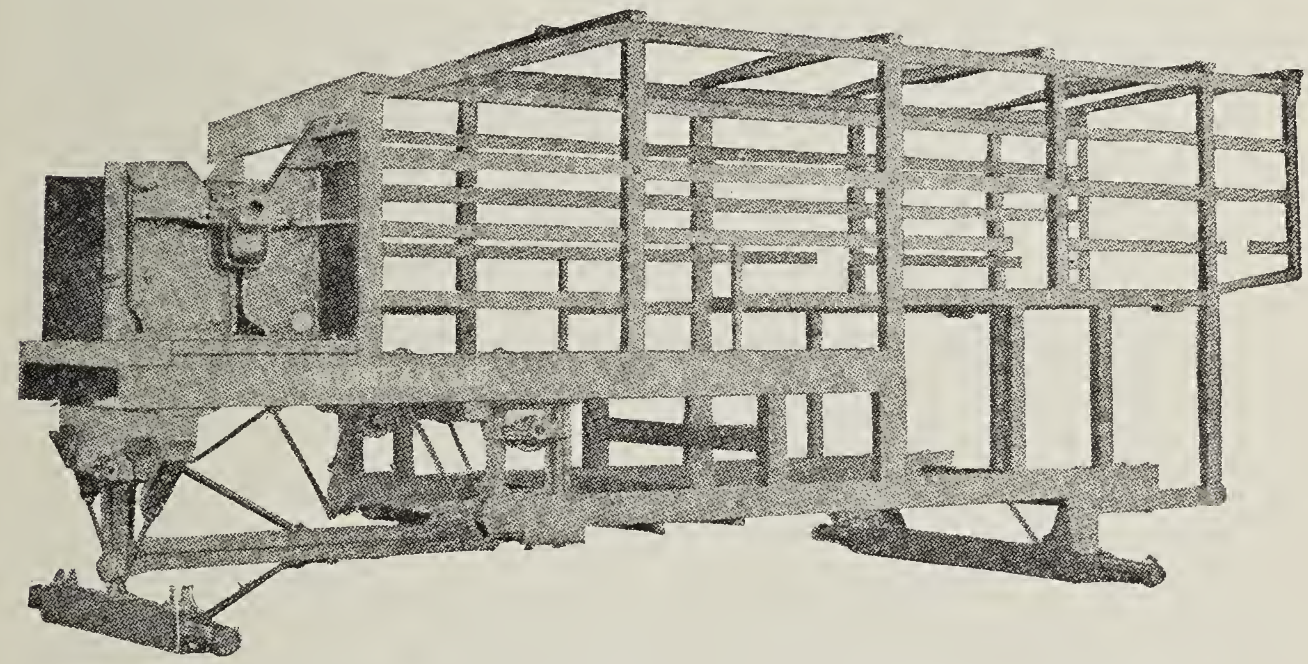


FIG. 32. VERY HEAVY FRAMEWORK OF MINNEAPOLIS SEPARATOR.

petence; a really good operator would never have started the machine until all parts were made to fit properly. Bad luck in handling machinery is generally another name for incompetence or laziness.

In figure 32 we present another illustration of a separator frame which shows both axles and the heavy iron sides which support the cylinder boxes. This is one of the largest and heaviest machines made and the frame work is strong and well put together. The foundation is very strong and provides a very rigid support for the superstructure. It will be observed that there is a reservoir in the casting just below the cylinder boxes. This is a part of the lubricating system which will be explained further on.

All machinery needs to be oiled when at work and grain separators are no exception to the rule. Every bearing needs careful attention and the proper kind of lubricant applied in the right quantity and at the right time. This practice intelligently carried out, together with intelligent care in the adjustment of all parts, will keep any machine in good working order a much longer time than they usually last. In order to run any machine successfully the operator must know his machine thoroughly and know what work every individual piece performs. He must study his machine and then learn how to make adjustments. This is best learned by working with some good mechanic, but if one has not this advantage he can learn by study and experience. The one thing to learn first of all is patience and self control. The fellow who goes into a panic when any accident occurs has no business running machinery of any kind. It requires a cool, logical, active brain to meet emergencies successfully. In addition to this a man must be able to work with patience and be content to achieve results slowly. There are a lot of people who are in too much of a hurry to get anything right. In handling machinery it generally pays to make haste slowly. We once had a young fellow working for us who always started in a job with great promise. He had intelligence and was a hard worker, but possessed the fatal defect—in a mechanic—of being in a tremendous hurry. He never made up a piece of work that was just right but was always pretty close. He was too easily satisfied. He knew better than he wrought, but was in a tempestuous hurry and anything was good enough. Such a man is very trying to get along with. You always expect him to do better next time and are always disappointed.

To return to the subject of lubrication: the cylinder bearings are, of course, the most important since all other parts of the machine are driven from the cylinder shaft and because these bearings are liable to be loaded very heavily. The cylinder itself is quite heavy, and when there is added the weight due to the pull of the belt, we have a load that at times becomes excessive and which requires a nice system of lubrication and a good grade of oil. The oil must have good body and good lubricating properties and be used freely. A medium heavy grade of machine oil will be found satisfactory or a good grade of hard oil. There are some hard oils or greases on the market, consisting mostly of paraffine, that have very little lubricating value. They work pretty well where the speed is low and the load light, but are not suitable for heavy work like cylinder boxes.

Some machines are fitted with boxes having ring or chain oilers. If these are made right and the proper grade of oil is used, it is one of the best ways to lubricate a bearing. It is the method employed

to lubricate the main shaft bearings of dynamo and high speed fans. The Minneapolis separator is fitted with this device as may be seen by referring to figure 32. Another method is to use a compression grease cup at the top of a piece of quarter inch pipe about a foot long. The pipe makes the cup easy of access and acts as an oil reservoir. This scheme works all right if the operator does not forget to screw down the cap of the compression cup once in a while.

There are a number of other bearings—not very heavily loaded—which are provided with a cup for waste covered with a cast iron cover plate. This is a very good scheme if the waste is kept saturated with a good grade of oil. It is the same scheme, by the way, used in lubricating car wheels on railroad cars. Where wooden boxes are used, as they are on the straw racks, graphite makes an excellent lubricant. It not only reduces friction, but, being dry, does not gather dust or dirt. A wooden bearing, by the way, makes a very good bearing where the load is not too heavy and the speeds are moderate. These were used very extensively in the old style flouring mills.

The operation and handling of a separator is rather a complicated process which requires time and study and experience to master. A man cannot be proficient by reading alone, nor by experience alone, but through a combination of reading and thinking and actual service. But above all, there must be study either of books or of conditions or of both. The writer has talked with men who boasted twenty years of experience who knew actually almost nothing about the principles of separation. Length of service is no guarantee of knowledge. It merely represents opportunity but there is no certainty that the opportunity has been improved. Some men never study. Every new fact has to be learned separately and they seem to realize no relation of cause and effect. What is needed above all things in running a separator is general intelligence—a mechanical temperament—and separator sense. It is not a lazy man's job, but on the contrary requires close vigilance. A careful inspection of the machine at every opportunity and good care are essential to keep a separator in running order. Some men throw the loose belts in on the sieves and cause them to sag in the middle, thus ruining them; others will leave the belts out over night and wonder why they have trouble, and so it goes. Sieves require to be perfectly flat to do good work and if they are sagged they are almost useless for fast threshing because the grain and chaff all go to the middle. Leather belts need to be soft and flexible and so should not be exposed to the night dews, neither should they be given a coating of any kind of sticky belt dressing. All they need is an occasional treatment of neat's-foot oil, and at the end of

the season a careful cleaning followed by a coating of neat's-foot oil, after which they may be laid away for winter.

The separator itself needs care at the close of the season. It should be cleaned out thoroughly, put in proper shape and then put away in a clean, dry place until needed again. It should be set level and if any part needs painting or repairing, the end of the season is the proper time to do the work and the man who has been operator should be in charge of the repairing. Even if he should be around the next fall he will not know as much about what is needed as at the end of the season's run.

CHAPTER VI.

HISTORY OF DEVELOPMENT OF THE SELF FEEDER.

Feeders and Feeding.—Before self feeders were invented all the straw was fed to the cylinder by hand. It was considered quite an accomplishment to be a good feeder and men who could do this work were paid somewhat higher wages than bundle pitchers or common laborers. It was, moreover, a job that required a special sort of skill. The bundles were pitched upon the feeding table and the bands were first cut by hand and then the man who did the feeding fed them to the cylinder. His task was to feed the bundles head first into the cylinder and spread them out evenly so that the ends of the cylinder received as much straw as the middle. Of course, no great pains were taken to make an even distribution as the bundles came up. The feeder merely lifted the butts of the bundles lightly, letting the cylinder teeth gather the top straws first and at the same time giving the whole bundle a dexterous flip that spread the straw quite evenly on the feeding table. Men who worked at this a whole season became quite expert and could do as good or even a better job than could be done with a modern automatic feeder.

When the self feeder came into use the problem was to duplicate as nearly as possible the methods of the best hand feeding. To do this it was necessary to make a machine that would feed only when the cylinder came up to threshing speed, that would spread the bundles evenly across the tables, that would cut the bands and that would elevate the butts of the bundles or in some other way cause the straw to be drawn from the top of the bundle first. Then some device had to be designed to prevent feeding too fast, or, in other words, "slugging the machine." These, then, were the requirements that had to be met in the design of a successful feeder. It was another big problem and one that engaged the attention of inventors for a number of years, but it was finally solved in a number of different ways.

Grain separators were quite thoroughly perfected before self feeders came into extensive use. In fact, it has been only within the last dozen years that grain feeders have come into general use, which is merely another way of stating that it has only been within that time that they have been sufficiently well developed to meet the needs of the business. While the bare recital of the requirements for a suc-

cussful feeder do not seem at first thought very difficult to attain, their attainment baffled inventors for a good many years. It is not enough merely to cut the bands and shove the bundle up to the cylinder. To make a machine of this sort would be a very simple matter, but it would not work satisfactorily for a number of reasons. In the first place, it would slug the cylinder and cause a heavy strain on the cylinder boxes and cylinder teeth. Second, it would slow down the whole separator and result in poor threshing and separation of the grain.

In the best hand feeding the straw was all fed lengthwise, all the bands were cut and the straw was spread as evenly as possible the entire length of the cylinder. The butts of the bundles were elevated and the cylinder teeth were allowed to comb the top straws off from the bundle first. Where necessary, the feeder retarded the under side of the bundles with his hands. He endeavored also to maintain an even, steady stream of the straw to the cylinder at all times. This made it necessary for the pitchers to pitch carefully and place all the bundles in such a manner that they could be handled easily by the band cutter and the feeder. Even with the most careful work it was a little difficult to keep an even blanket of straw going into the cylinder continuously.

The first mechanical feeders that were made had many of the features which are common today, although the mechanism has changed considerably since the first machines were invented. The inventors realized the situation and knew the needs of the business quite definitely, but there was nothing to guide them in regard to the form of mechanism, or, rather, details of mechanism that would give the best results in practice. These details had to be worked out by trials extending over a term of years. One of the earliest forms of feeders which was placed on the market and one of the first to obtain recognition consisted of a revolving raddle which carried the grain to the threshing cylinder. Just before reaching the cylinder the bundles were delivered upon a spring supported platform which was slotted. Fingers from below came up through these slots and acted as retarders for the lower side of the bundle. Immediately above this spring platform there was another revolving raddle working in an almost vertical position, but with the lower end pointing toward the cylinder. This raddle was provided with spikes which, as they revolved around, caught the straw from the upper part of the bundle and delivered it rather high up on the threshing cylinder. (See figure 33.)

Here we have the main elements of the modern successful feeder. The bundles were delivered to the threshing cylinder by means of a revolving raddle, retarders prevented the bundle from going directly

into the cylinder, and a device was arranged to feed the upper straws into the threshing cylinder first. There was a revolving disc having teeth which caught the bands of the bundles and brought them up against stationary knives. Here we have a crude form of band cutter. The feeder was also provided with a governing mechanism which depended for its action upon the volume of straw going into the cylinder. When the amount of straw which was delivered to the spring mounted feeding board passed a certain predetermined amount the spring became depressed, the board moved downward and operated a lever which disengaged a clutch and and stopped the main feeding raddle. Just as soon as the bundle which operated the governor was disposed of, the spring platform rose and the feeding raddle again started to work. In this machine, which was rather crude, there was no means for spreading the straw uniformly across the cylinder. It possessed many mechanical defects not found in feeders at the present time, but aside from the one thing mentioned it possessed all the requisites of a modern self feeder.

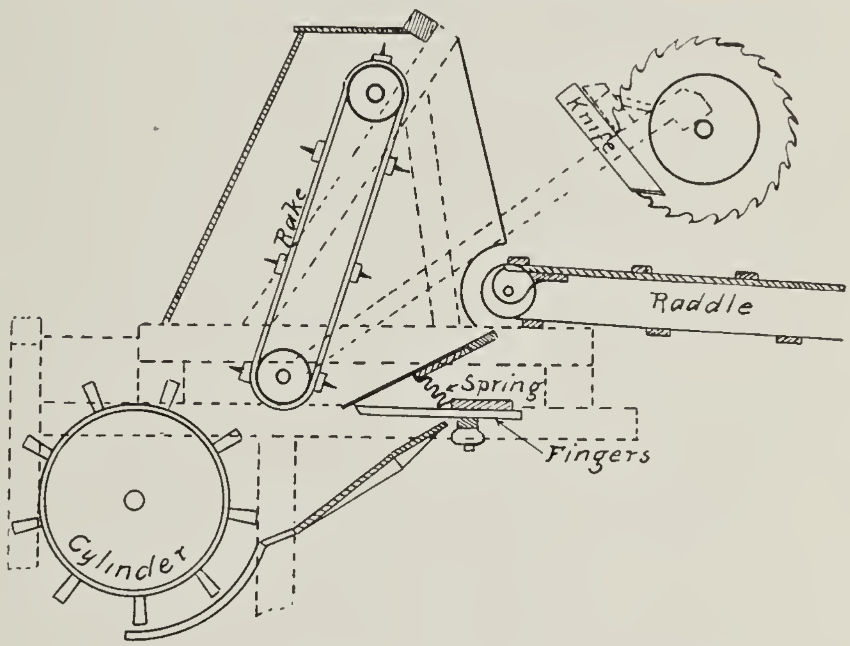


Fig. 33. AN EARLY TYPE OF SELF FEEDER.

In mechanical feeding just as in hand feeding one of the essential requirements is that the grain shall be fed as steadily and uniformly as possible in order to keep a steady stream of straw passing through the cylinder at all times and to make the whole machine work at an even, uniform rate. It is very essential, as has been pointed out previously, that the separator work at a constant rate of speed and this speed should be the one best adapted for the work in hand. If the speed of the cylinder varies, it follows that the speed of all other parts of the machine will also vary since they are driven from the cylinder. This being the case, poor threshing will result and also poor separation. To obtain the best results, therefore, the self feeder must deliver the straw at a uniform rate regardless of how fast the pitchers throw the bundles upon the platform. This calls for very close governing. It is, furthermore, not advisable that variations in

the speed of the separator be utilized to stop the self feeder carrier. When grain is feed into the cylinder its speed is somewhat checked during the succeeding instant and until the steam engine governor can act and deliver more power to the main drive belt.

Likewise, if, while the cylinder is working hard, it suddenly runs out of straw its speed will increase for an instant until the engine governor can again act and cut off a part of the steam supply. The result of this intermittent motion is poor work and it is the office of the feeder governor to feed an equal amount of straw continuously and thus prevent any such action.

The amount of extra power required to run the separator fitted with a feeder is probably rather slight. There is, of course, the friction of the various parts to overcome and a certain amount of power is required. However, when it is properly designed and working correctly the straw is delivered at a much more uniform rate to the cylinder than by ordinary hand feeding and there is less slugging of the cylinder and the machine works to much greater advantage.

The self feeder made fast threshing possible because it replaced uncertain hand feeding for the more perfect and tireless work of a machine. Hand feeding when done well and conscientiously was very hard work and it taxed a man's endurance to the limit to stand on the feeding platform all day and take care of all the bundles that three or four pitchers could deliver to him. Under such conditions as these, and they were common in the West, feeding was not generally well done. Furthermore, it was a more or less dangerous position for both the feeder and band cutter. If a stick or a stone or a fork went into the cylinder, as they frequently did, broken pieces were very apt to fly back with terrific force and many men were seriously injured in just this way.

There was also the danger the feeder encountered of getting cut by the man who cut the bands. Where both worked at top speed it was almost impossible to guard against this danger and consequently many men had their hands badly cut every season.

The self feeder did two other things that perhaps more than anything else led up to the rapid introduction and these were that it dispensed with the services of two men, both of whom commanded more than ordinary laborer's wages and it increased the capacity of the entire machine. These facts were the two outstanding points in favor of its adoption and which brought it into such almost instant prominence. It is a fact that it practically displaced hand feeding completely in less than five years after it was perfected.

We will describe some of the feeders now on the market, not with the idea of presenting anything new, but with the thought in mind

of bringing together a description of the various feeders that the student may obtain thereby a fair idea of the subject and be better enabled to draw comparisons.

The first feeder which we will describe is the well known Parsons feeder. This machine was first placed on the market in 1892, and was one of the first to gain recognition generally among threshermen. During the first years of its existence it met with the usual opposition accorded to all new inventions and not the least of these was the hostility of men who operated threshing machinery. They not only did not use good judgment in feeding the machine, but on the contrary did whatever they could to crowd it beyond its capacity. This was comparatively easy because of the fact that it was not at first equipped with a governor acting on the feeding raddle as in modern machines. Men who, during the season, had always depended upon feeding and band cutting for their season's work derided the new device and used their influence against it. In this respect, only in a lesser degree, it went through the same period of hostility from labor that the reaper and other farm machines encountered. It is only natural that men who see their jobs taken away from them by machinery should evince hostility to the machine and endeavor to prevent its introduction. Fortunately for the world, such efforts have always in the end proved fruitless. It was thus in the case of the self feeder. While it had to meet and overcome opposition in the beginning, this was effectually done in the course of a very few years. Another difficulty that was even harder to overcome was that of perfecting the details to meet every condition of grain. To do this, it was imperative to build a machine that would be adjustable in all its parts to accommodate the different kinds and conditions of grain and sizes of bundles found in various parts of the country. These conditions made it necessary to equip the feeder with a governor and with a variable speed device, both of which will presently be described. Minor changes and improvements have been made from year to year, but all of the distinguishing features such as variable speed device, governor, etc., were incorporated by the end of the year 1895.

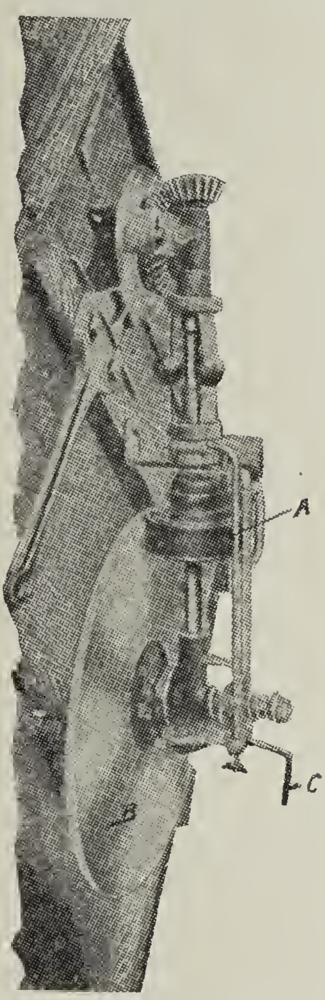


Fig. 34. Governor of Parsons Feeder.

It may be well to mention the fact here that the Parsons feeder was not the first one to meet with success in the field, as a number

had been invented and placed on the market prior to this one, but its advent marks the beginning of the universal use of these useful machines.

As it exists today the Parsons feeder is very well understood by the rank and file of threshermen, nevertheless we will take up and discuss its various features. Like all other feeders it is equipped with a revolving raddle which carries the bundles to the cylinder. This endless rake or raddle consists of two sprocket chains to which are attached hard maple slats armed with teeth that project backward to facilitate their drawing out of the bundles easily when the latter are delivered at the cylinder of the separator. These teeth serve the further purpose of holding the lower part of the bundles when they pass under the knives of the band cutter. In order to better adapt the feeder to different conditions of grain, the speed of the raddle may be varied at the will of the operator, that is, it may be made to feed fast or slow as desired, but at all times it runs slower than the knives and separating device of the machine. This is done with the purpose of retarding the lower part of the bundles and causing the straw to be fed from the top of the bundle.

The means by which this variable speed is obtained is clearly shown in the illustration on page 89, figure 34. A small rubber faced wheel, marked A, engages, by means of frictional contact, with a large flat disc, B. When the small wheel is at the outer edge of this disc, the latter is driven slowly, but when it is drawn nearer the center by means of the speed changing lever C, the disc is driven faster. This disc is keyed to a short shaft which is geared to the raddle and thus causes it to revolve faster or slower as the case may be. The small driver receives its motion from the bevel gears and cross shaft shown at the top of the picture and they in turn are driven from the cylinder shaft by means of a belt on the opposite side of the machine. It will be noticed also that this operates in connection with a governor of the ordinary Pickering type which operates a clutch, plainly shown in the illustration.

When the cylinder speed reaches a certain predetermined number of revolutions for which the governor is set, it operates in the usual way. The balls fly outward on account of the centrifugal force acquired through rotation and throw in a clutch which causes the small rubber faced wheel to rotate and so start the raddle rakes in motion. It will thus be seen that the feeder will not begin delivering straw to the separator until the cylinder has acquired threshing speed. By a reverse series of operations, if the cylinder speed falls below its normal threshing speed, the governor will again operate and prevent the operation of the feeder raddle.

The variable feeding device is useful whenever a very difficult piece of threshing has to be done; for example, in the case of wet or matted bundles, the raddle can be made to travel slowly while the knives and separating devices loosen the straw and tear it apart so that it will not slug the cylinder.

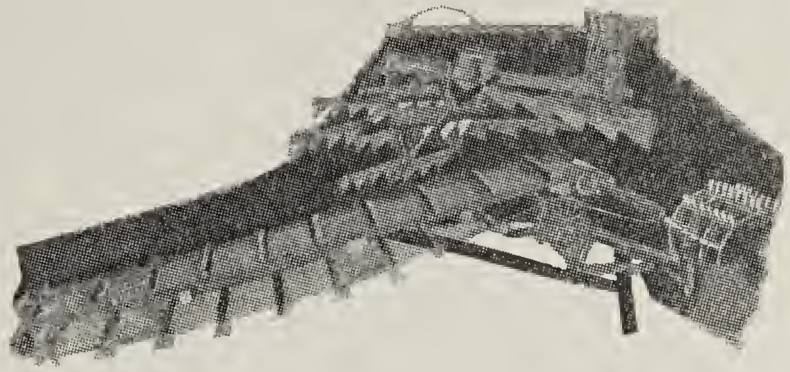


FIG. 35. SHOWING CONSTRUCTION OF PARSONS FEEDER.

The bands are cut by means of a set of serrated knives like those used in the cutting bar of a mowing machine and driven from a multiple crank shaft. The rear end of the knife bars has an oscillating motion on account of the way they are hung from the top of the frame work by hangers, while the front end receives a rotary motion from the crank shaft. Immediately back of the knife sections there is a set of fish backs which aid materially in tearing the straw apart and especially in feeding the top straws to the cylinder first. In the Parsons feeder the normal rate of speed for the knives and fish backs is two hundred and sixty revolutions per minute. The internal arrangement of the feeder showing raddle, band cutter knives and fish backs is shown clearly in figure 35.

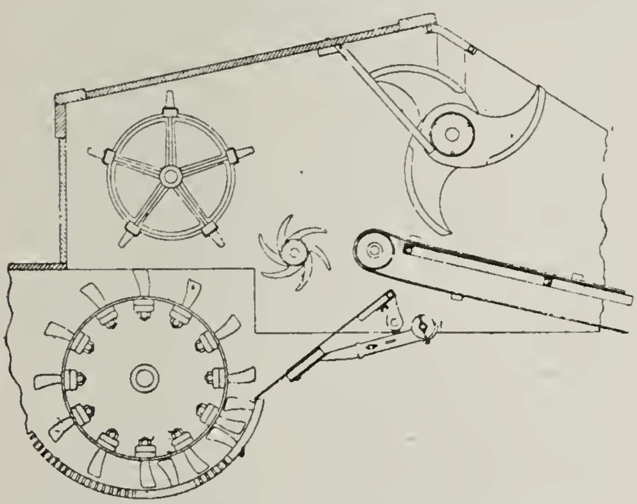


FIG. 36. SECTIONAL DRAWING OF RUTH FEEDER.

In the machine which has just been described it will be observed that the cylinder of the separator must first change its speed before the feeder governor can act and either stop or start the raddle. It has been recognized that this is not exactly the correct principle, although in practice it has worked very well. A better scheme is to make the feeder itself sensitive to an overload in order that it may deliver a continuous and uniform quantity of straw to the cylinder, thus preventing any change of speed at that point due to slugging.

A number of machines have been devised on this principle. The Ruth feeder made by the same company that manufactures the Par-

sons is equipped with a governor which is actuated by the retarder cylinder.

The Ruth feeder is provided with a rotary knife band cutter. The knife sections are made detachable and interchangeable. Their function is merely to cut the bands. They do not have as much effect in spreading the bundles as the knives used on the Parsons feeders. The distinctive feature of this feeder is the governor which controls the volume of straw delivered to the cylinder of the separator. Reference to the drawing, figure 36, will show that back of the knives and almost directly over the threshing cylinder there is located the feeder cylinder. Below this and to the right of the threshing cylinder the retarding shaft with its fingers is located. All the straw which is fed to the machine must first pass the feeder cylinder. If a heavy mass of straw leaves this point, the feeder cylinder will be slackened in speed, thus operating a trip lever which disengages a clutch and stops the raddle. No more straw, therefore, can leave the feeder cylinder until it has taken care of the masss which has caused the disturbance. The circumferential speed of the feeder cylinder is about four thousand feet per minute and the retarder about forty feet. Thus it will be seen that the straw from the upper part of the bundle will be combed off and delivered to the threshing cylinder while the lower straws are retarded.

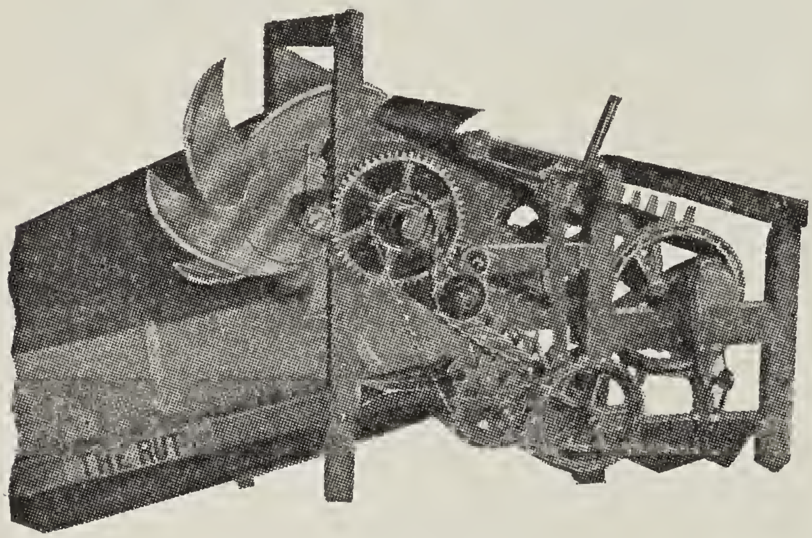


Fig. 37. side view of ruth feeder, showing governor on outside.

The retarder shaft may be raised or lowered while the machine is in operation, thus making the throat larger or smaller as desired. The governing in this machine, it will be observed, does not depend upon variations in the speed of the threshing cylinder but in variations of the speed of the feeder cylinder. The threshing cylinder maintains a uniform rate of speed provided the engine governs properly while the feeder performs its function of delivering a constant and uniform volume of straw at all times regardless of how large a quantity is thrown upon the feeder platform. The position of the governor, which is of the Pickering type, is clearly shown in figure

37. It is driven by gearing from the shaft of the retarder cylinder and disengages a carrier trip that starts the raddle in motion. This feeder cylinder quite effectually prevents the slugging the the separator by thoroughly disintegrating any matted or tangled masses of straw. The feeder cylinder is light, weighing less than two hundred pounds, and is fitted with teeth about an inch and a half long. Grain is delivered high up on the threshing cylinder and in almost a vertical position, that is, the butts of the bundles are elevated.

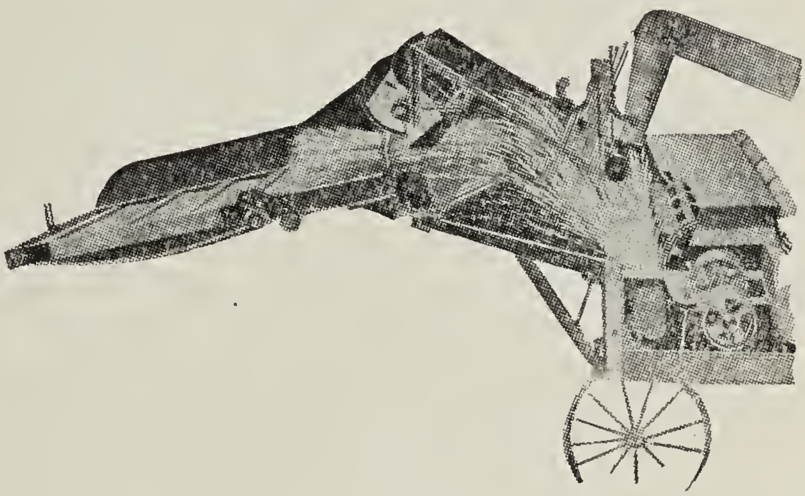


Fig. 38. side view of wood bros. feeder.

Another very successful machine is the Wood Bros. steel self feeder. The distinguishing features of this machine are the bundle spreader, the feeding forks and the governor. The general arrangement of the various parts are brought out in figure 38. Immediately back of the upper part of the raddle may be seen the fingers of the bundle spreader. These have both an oscillating and vertical movement whose duty it is to spread the bundles evenly the entire width of the cylinder. Immediately behind these are a number of feeder forks operated by link work from the band cutter shaft. These forks are made adjustable and can be raised or lowered, thus regulating the side of the throat to the different conditions of the grain. An automatic friction governor mounted on the end of the band cutter shaft regulates the amount of straw delivered to the machine. This governor is very sensitive and responds to a variation of less than a hundred revolutions of the thresher cylinder. Whenever the speed of the thresher cylinder is reduced, the speed of the governor is reduced a like amount, thus causing the weights shown at A, in figure 39, to approach near the center of the shaft and thus preventing the band wheel B from rotating. This band wheel drives the raddle by means of a sprocket on the rear side while the spider which carries the weights is fastened by means of a set screw to the band cutter shaft. When the speed of the

Fig. 39. details of automatic governor used on wood bros. feeder.

band cutter, which is driven from the threshing cylinder, reaches a predetermined amount the weights fly outward and the shoes S engage with the inner rim of the disc B, causing it to rotate and thereby drive the raddle and feeder forks. One advantage in a governor of this type is that it takes hold gradually and does not jerk the machine, because as the speed of the cylinder gradually increases, the friction of the shoes S, on the disc B, gradually increases until no more slippage occurs.

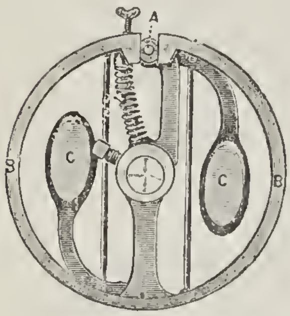


FIG. 40. GOVERNOR OF LINDSAY FEEDER.

Figure 41 presents an internal view of the Lindsay feeder and shows the general arrangement of the parts.

It is always interesting to learn how men have struggled to achieve success. The stories of difficulties met and overcome, of failures, of disappointments and of ultimate success in the field of invention are not less interesting than stories of war and of adventure, but fewer of them are told. Successful inventors are busy men and few of them care to write, consequently stories of how they worked and the sacrifices they made are very scarce. Some one said in our hearing recently, "It is too bad that somebody doesn't write a book, not about what experiperiments succeeded but what failed." If such a book were written the world would be richer by a great deal, but curiously enough we never care to know about the failures until we actually try to do the same thing ourselves, and then we realize that they tell much more than the successes and a record kept of them would be of untold value to the next laborer in the same field. If we only had such records in our libraries to guide us—records of the failures in every line that men have investigated, all tabulated and indexed, the world would progress much faster because we would not have to thresh over old straw. Undoubtedly most of the inventive energy of the world is expended in doing what some one else has either done or proven can't be done. Even the professional scientist is careless about publishing an account of his failures even if he ultimately succeeds, and if he does not succeed, his pride will keep his lips closed and his pen idle.

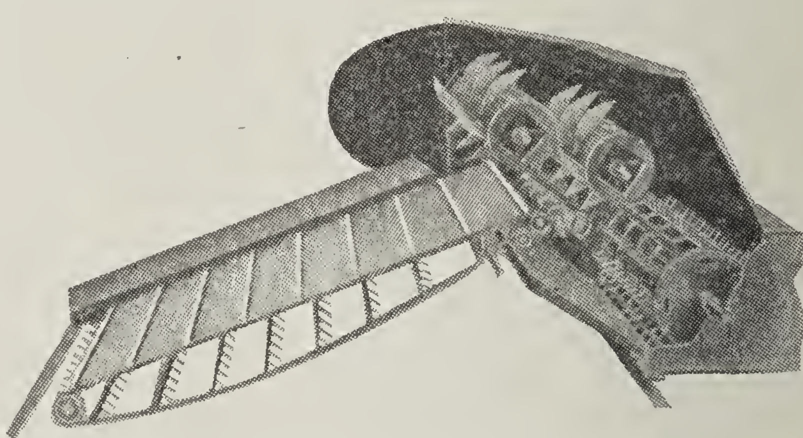


FIG. 41. SIDE VIEW OF LINDSAY FEEDER.

It is always easy to see why a certain thing does not work after you have tried it out. The things that do work right seem so perfectly natural we always wonder why no one ever thought of them before, but the explanation is easy—people are not often gifted with the constructive imagination, the ability to step out into the unknown and think another step forward. When the job is completed and success achieved we look at the completed work and know it is right, because things that are right look right, as a rule.

Very few stories have been written about the invention of the grain thresher or of any of its parts, although many of the inventors are still alive. We are very much pleased, therefore, to publish the experience of Mr. F. H. Marshall of Darlington, Indiana, who was one of the first successful inventors of the self feeder. He not only tells of his success, but tells about a number of things that were tried and found wanting and these are not the least interesting parts of the narrative.

"I will endeavor to give you my experience with band cutters and feeders for threshing machines. It is so long since I have given the matter any thought and as many of my papers relating to the same have been lost or destroyed, I will have to depend principally on my memory. In the first place, it might be well for me to give a few reasons why I became interested in a self feeder. In 1882, the farmers and the threshers in this locality were considerably troubled in getting sufficient help during the threshing season and especially help that had had experience in cutting bands. So the idea occurred to me, why not make a pitch fork that will cut the bands and let the men who pitch bundles cut the bands? After thinking the matter over for a time, I concluded I could make a knife to cut the bands and attach it to an ordinary pitch fork. I first made a small wooden model of what I thought would do the work and it looked so good that I applied for a patent. But after I had a full sized cutter made and tried it, I found it was not practical, not because it would not cut bands, but because it was very awkward to operate, and would cut the bands usually at the wrong time. I gave it up as a failure but not until I had sold half an interest in my patent for enough to let me out whole with regard to the time and expense I devoted to it. Patent was issued March 23, 1863.

"In the meantime the thought occurred to me, why not make a machine that will cut the bands and do the feeding too and take the place of three men instead of two? My first model was soon completed and while it lacked much of being perfect the fact remains that I have never changed the fundamental principles of design, and there is not a self feeder on the market today that does not use some

or all of those same principles. After getting the model completed I could see no reason why a full sized machine would not work equally well on a separator, and proceeded to have it patented. Having had some experience in the patent business I concluded to let my brother, J. A. Marshall, furnish the money and take a half interest with me. Before we got through we had obtained two patents on a band cutter and feeder. The first one was issued January 29, 1884, number 292,667, and the second on December 9, 1884, number 309,074. We also obtained a Canadian patent but never did anything with it. After we had made our first application for a patent in 1883 we concluded to make a full sized machine and give it a test. As neither of us owned a threshing outfit, we had to arrange with the different threshermen in this locality to let us try it on their separators.

"Mr. Ed. Greist was the first thresherman to grant us the privilege and we were not very long in making the test. We had not provided for making any changes in the speed of any part of the feeder and found that it was speeded too high, therefore all we could do was to take it off and make the necessary changes. By the time we could get it ready for another test the threshing season was nearly over and it had been reported over the country that our feeder was a complete failure. We were not to be discouraged, however, by idle gossip and immediately arranged with John Dukes, who ran a threshing outfit east of Colfax, to let us make the second test on his separator at his home. Mr. Dukes was very nice to us in giving us all the time we wanted in attaching the feeder and making the test and did all he could to assist us. We were again doomed to disappointment. The feeder worked fine for about half an hour, when all at once it came to a dead stop. It took some time to locate the trouble and we found that a change in the feeding device would be necessary to overcome it. By this time the season was so far advanced we were obliged to wait another year to continue our experiments.

"In order to give the reader a better understanding of our troubles it will be necessary to present at this point a short description of our feeder. The main frame or bundle carrier was six feet long and thirty-two inches wide on the inside. Our band cutters were round knives or discs with continuous cutting edges which revolved at about 300 revolutions per minute. Our feeding device consisted of five reciprocating vibrating pans operated by revolving shafts with a separate eccentric for each pan. Up to the time we made the second test we had placed the eccentric shaft next to the threshing cylinder and let the outer ends of the feeding pans slide on an iron rod under the front of the bundle carrier, but in attaching the feeder we placed the feeding pans above the feed board in the yoke of the separator in

order to prevent the loose grain and straw that sifted through between the feed pans from falling to the ground and this was what caused the trouble in our second test.

"The eccentric shaft revolved toward the threshing cylinder and this caused the eccentrics to rake all of the shatterings back under the feeding pans, thus stopping the machine. It is perhaps safe to say that nine out of every ten people who had seen our machine were by this time convinced that we could never make it work successfully, but we were far from being discouraged. In 1884 we arranged with Birch Brothers at Crawfordsville, Indiana, to furnish us with the necessary castings and do the machine work for us. We had discovered we could make several minor changes in the feeder without changing the principles, the most important of which was the changing of the position of the eccentric shaft by placing it at the outer end of the feeding pans and allowing the other end to slide on the feed board. We also changed the raddle carrier for a canvas carrier, made sliding boxes for the outer roller so that the slack in the bundle carrier could be taken up without having to stop the feeder and arranged for three different speeds for the bundle carrier. We felt that our 1884 self feeder was about perfect and arranged to put out two or more that year. Only two were built and we found a little later on that they were all we cared to look after that season.

"The changes above mentioned corrected the first troubles, but we discovered after running a few hours that we had other difficulties to overcome. Our band cutting knives were only twelve inches in diameter and by placing the center of the shaft so that the knives would come within five inches of the bundle carrier, we found that it was set too close to the carrier for the different sized bundles. We also found that the knives got so dull after a few hours' run that they would not cut the bands. We could easily sharpen the knives but could not raise the shaft any higher without getting the knives too high, so we decided, as the discs or round knives were rather expensive, we would try a set of curved knives sixteen inches long with sickle edges. We found the new knives were all right and that we could raise the cutter shaft high enough for all practical purposes, but in order to keep it from wrapping in damp straw we had to put the round knives on with the curved ones.

"By this time we had most of the mechanical difficulties overcome, but our troubles did not end here. The machine did not find favor among the farmers and every man who expected to get good wages for feeding a threshing machine condemned our feeder. We did not have a center board on the carrier, but depended entirely on the pitchers to pitch the bundles straight. They were not very long in finding

that they could pitch the bundles crosswise and cause trouble and many of them seemed to delight in doing it. To overcome that trouble we put a half inch iron rod lengthwise over the center of the carrier and high enough to keep the bundles straight but it was not very successful; if placed high enough to answer the purpose, bundles were apt to go under it crosswise and when a bundle was pitched hard against it there was enough spring in the rod to throw the bundle off of the carrier. After finding the rod did not accomplish the purpose, we substituted a sixteen-inch center board, and then the pitchers growled. They complained that the space between the center board and the sides of the carrier was too narrow, but we insisted that it be used and that the pitchers exercise greater care. We finally won out and it is still a feature on all feeders.

"Our experience with both feeders was about the same and while we were pleased with the progress we had made we did not insist on either of the feeders being kept on during the entire threshing season. One or two weeks of worry and anxiety was about all we cared to stand in one season. We had the satisfaction of knowing, however, that the feeder was beginning to make friends. Both the threshermen and farmers saw that it would not only eventually be made to work but that it would save them the expense of two men during the threshing season.

"We succeeded so well in 1884 that we concluded we would put out six or eight feeders the next year and branch out farther from home. I attached four feeders in Fountain county and got them started in good shape early in the season of 1885 and felt I would not have much trouble with them, but I was again doomed to disappointment as two of them did not run over a week or ten days before they were taken off.

"About this time I began to learn something about human nature. Much of the grain was in bad condition and hard to feed without slugging the cylinder occasionally even with hand feeding and many times I saw hand feeders slug the cylinder hard enough to throw off the drive belt. Whenever the self feeder did any slugging there was a great howl about it, and yet it never at any time slugged hard enough to throw off the drive belt. I was fortunate in getting two of the self feeders into good hands. One with Mark Furr and the other with Howard & Whitesell and both of these ran through the threshing season and gave very good satisfaction.

"In 1886 we had as many self feeders on hand as we cared to look after, considering that, so far, it had been most all expense and no profit to us. Therefore, about all we did was to overhaul those that had been taken off, find places for them and look after those that

were kept on. From our past experience we concluded it would be better to give more attention to those that were sold than to new work. In fact, we felt a little discouraged and were not as enthusiastic as we were in the start. But we knew we had at least one friend loyal to us, who had faith in the self feeder, and he was no other than Mr. Mark Furr, who lives about two miles west of Mellott.

"Mr. Furr was one of the oldest and best threshers in Fountain county and when it came to threshing his word was law and gospel. Therefore, I spent from one to four days each week during the threshing season with Mr. Furr. I paid particular attention to the self feeder and we got along so well with that that Mr. Furr thought it would be a good plan to exhibit it at the Montgomery county fair at Crawfordsville and proposed to take his separator. We accepted Mr. Furr's proposition and arranged for the power and two good sized loads of wheat to be on the fair grounds on Thursday, as that was the biggest day of the fair. Mr. Furr had his separator and self feeder there in good time and on Thursday afternoon we threshed the two loads of wheat without a stop.

"In 1887 I spent most of the threshing season in Fountain county looking after the feeder on Mr. Furr's machine and keeping it in the best of shape as the Advance Thresher Company had begun to make inquiries about it and might at any time send a man to see the feeder in operation. Mr. Furr had finished shock threshing and was threshing stacked wheat when a gentleman drove up to the machine and introduced himself as Mr. Snyder from the Advance Thresher Company and said that he had come to investigate the band cutter and feeder. I told Mr. Snyder he was welcome to any investigation or tests he desired. He stayed with us several hours and when he was ready to leave he was convinced it would do the work and promised us a favorable report to the company. It was several days before we heard anything from the Advance Company, but we finally got a letter from them saying that Mr. Snyder had made a favorable report on the feeder but they would like to see one tried on one of their separators.

"We shipped a feeder to them and some time afterwards they wrote us they had given it a trial in oat threshing and it worked all right. As their biggest trade was in the Northwest they asked permission to ship it there and try it in wheat threshing. We heard nothing from them until April, 1888. We were getting a little anxious to know what had become of the feeder so I wrote them about it. They answered by saying that they had shipped the feeder to Minneapolis late in the fall but by the time it got there threshing had stopped on account of the cold weather, but they wanted to try it that spring.

"I was engaged to make the trial and was ordered to report to Mr. Walter Gregory. He had been notified that I would be there and was looking for me and prepared to fire all kinds of questions at me to answer. I was satisfied he was trying to shake my confidence in the feeder and was prepared for him.

"The feeder was damaged in shipping and I sent home for repairs but I had plenty of time to get them as Mr. Gregory told me it would be two or three weeks before they could do any threshing. I got my repairs in good time and had the feeder ready to attach several days before they were ready for it. The feeder was to be tested at or near Mellette, South Dakota, and Mr. J. O. Humphrey, agent at Northville for the Advance Thresher Company, had charge of the arrangements. I was at Minneapolis several days before the feeder was shipped to Mellette and went to Northville and waited several days more before they were ready.

"While at Northville I made it a point to get acquainted with the gentleman who owned the outfit that was going to do the threshing. I wanted to know how he felt with reference to self feeders and what assistance I might expect from him. I found him ready to do anything he could to assist me although he was, like a good many other threshermen, not overburdened with wealth. He had a 36x52 Advance separator and, if I am not mistaken, a 16-horse power Ames traction engine, but before we could attach the feeder to his separator we had to take out the cylinder shaft and put in a larger one in order to put on a pulley to drive the feeder. We got everything in shape and made the test on Wednesday, May 9. Mr. Humphrey came to Minneapolis before I left Mellette and while there Mr. Gregory instructed him to give me all the assistance I needed in getting ready for the test.

"The outfit was run by a full crew of men, which made it better for me. They slept in a tent the night before and as the weather was rather cool in the mornings I deemed it necessary for me to take them something to warm them up and keep the microbes out. I had explained everything about the feeder to them the day before and they knew just how to handle it, so when we made the start everything worked fine and there was not a bobble anywhere.

"After we had threshed for two or three hours without a stop, Mr. Humphrey decided the feeder was all right and wired Mr. Gregory to that effect. Mr. Gregory wired back that he would be on hand the next morning and see the feeder in operation.

"Mr. Gregory was of the opinion that no man or machine could feed an Advance separator more grain than it could handle successfully and was afraid the feeder would not feed fast enough. It rained

Wednesday night and we left two stacks of wheat open or only about two-thirds of them threshed. The gentleman who owned the wheat decided that it would be too wet to thresh on Thursday, therefore the whole crew was in town when Mr. Gregory arrived. He was not to be disappointed, so he offered to pay for the wet grain if the gentleman would let him thresh it. His offer was accepted and we started the machine as soon as we could. When we were to start, Mr. Gregory got on the top of the separator to watch the feeder. We had tried all three speeds on the bundle carrier the day before and found the middle or second speed would give the separator all the grain it would handle and it was on that speed when we started Thursday. The speed was fast enough to keep two men very busy pitching all the bundles it would carry. We had run only a few minutes when Mr. Gregory concluded that it was not feeding nearly fast enough. I changed the carrier to fast speed and put on two more pitchers and it only took a few minutes to fill the separator so full of straw that the belts came off. We stopped, cleaned the straw out of the separator, put on the belts and were ready to try again. Mr. Grgeory finally concluded the second speed for the bundle carrier would be about right for damp straw. I changed the speed of the carrier back to where I had run it the day before and we finished the two stacks without any trouble. Mr. Gregory was more than pleased with the feeder and wired the factory it was all right and insisted on my going to Battle Creek with him at once and arrange for the Advance Thresher Company to build them. I did not go at once with Mr. Gregory but concluded to spend a few days in looking around. After I had spent two or three days in Watertown I went to Minneapolis and went from there to Battle Creek with Mr. Gregory and on May 15 I gave the Advance Thresher Company an exclusive contract to build our feeders on a royalty and arranged to superintend the building of the first feeder they made and furnish them with the different parts we might have on hand. I came home and spent a few days in getting things arranged and went back to Battle Creek to build self feeders and worked there until the last of June.

"In the meantime we had got several feeders ready to ship and, if I am not mistaken, the first one was sent to Hopkinsville, Kentucky, and it was the first one I attached and started after the company began building them. I got the feeder attached and started in good shape but as I had been there several days waiting for the outfit to start I had no more time to stay with it. I don't know how many feeders the company put on that year but I know there were a good many more than I could look after. I went to Geneseo, Illinois, next to look after a feeder that had been started and failed to work

right. I found the main cause was due to the way it had been attached. I got it in shape and left it going all right. I found the same condition existing there that I had found in many other places, and that was the hand feeders' determination to make the self feeder fail if they could and many of them did it as soon as I had left.

"For the first few weeks I was kept busy starting and attaching feeders, but it was not long after threshing began before trouble commenced and we had plenty of it the balance of the season and about all I did from that time on was to put on and start feeders that had been condemned and taken off. Every feeder I put on and started worked fine as long as I was with it and as soon as I left, in many cases, trouble began.

"The feeders were built without governors, therefore we had to depend upon the pitchers to feed the machine evenly. I had been with Mark Furr in Fountain County, Indiana, long enough to learn how to speak out in meeting and whenever I found the pitchers trying to give the feeder the worst of it I always had something to say. Of course I would find a contrary one once in a while but usually managed to trade him for a better one.

"I was in Kentucky, Iowa, North and South Dakota and Minnesota during the threshing season and my experience was about the same wherever I had anything to do with self feeders. I stayed in the Northwest until the first of November, when I concluded to come home. I wanted to do a little more experimenting with the self feeder so I took the outfit my brother had been running and ran it three years longer. The center board in a feeder had always seemed to be a necessary nuisance but I had an idea that I could make a feeder that could handle the bundles successfully in any shape or condition and before I quit threshing I had a feeder without a center board. I tried several different devices such as cutting the bands from the bottom and a side shake feeding device, and found they were not as good as the old way. I did find that I had to make the fight right at the cylinder to keep it from slugging. The last season I threshed I told the pitchers they had a space of thirty-six inches wide to pitch onto and to pitch the bundles straight if they could, and to pay no attention to the ones that went crosswise. In fact, I had the feeder going so well that I got an extra half cent a bushel for using it, and to keep a long story from getting much longer will say that all we got out of the feeder would not any more than let us out even for the time and money we spent on it, although the companies were building them on a royalty."

The difficulties encountered by Mr. Marshall illustrate very clearly the antagonism of the people of that day toward anything new which

was liable to disturb existing labor conditions, or which ushered in a new system of doing work. It has taken fully a century to educate the masses in this country to a point where they do not look with alarm upon every new labor saving device. This changed attitude on the part of the people is due in part to the general diffusion of knowledge through books and the public press, and to the further fact that they have seen that even if a particular industry is given a new machine to work with, the inevitable result is the cheapening of the product to a point where its market is broadened and instead of making labor less needful it increases the demand for labor, though perhaps not in the same field. Such has been the case in agriculture, in printing, in foundry work and in transportation. Many more illustrations might be cited but these will suffice to show that the proposition is perfectly general.

It is an easy matter now to introduce a new machine compared with what it was forty or fifty years ago. People have learned that improved machinery cheapens production and stimulates trade. This in turn creates a demand for more labor. It is true, in this country, that labor saving farm machinery has driven thousands of laborers to the cities, but they have found increased opportunities awaiting them in the shops of the great manufacturing establishments at better wages and more reasonable hours than they ever knew on the farm. The great mass of laborers have been benefited rather than injured by the change. They have greater social advantages, better schools and steadier employment than they could hope for in the country.

In the thickly settled parts of Europe and in the Orient, conditions are different and it is much more difficult to make the people understand how changes in the methods of production will affect them. They are not so well informed for one thing and manufacturing has not become so well established. Any radical change in farming methods in the Orient would mean starvation for many of the laboring classes. Conditions have been fixed in the grooves of centuries and there is not only the prejudices of ages to overturn but the difficulty of finding a place where the man in agriculture would fit in if he were forced out of employment. For progress of any particular moment to take place in that part of the world, in agriculture, it must first begin in manufacturing to provide an outlet for those whom it is intended to displace on the farms. The cheapest power in the Far East is the power of human muscles.

The industrial era in Europe was ushered in after the terrible social upheaval of the French Revolution and the wars of Napoleon. These events shook up conditions to such an extent that it became a

necessity to introduce labor saving machinery to do the work that had to be done if people would eat and be clothed. It was an economic necessity brought on by the changed conditions. Had it not been for these wars it is improbable that the world would have seen such rapid advancement in the direction of science and invention as has been witnessed in the past one hundred years. Another thing that made such progress easy was the opening up of great areas of fertile lands in the United States, in South America, in Australia, in Canada and in other parts of the world.

All of these things have had an influence on and advanced the various industrial arts to their present state, but in none of them has there been greater advancement than in farming machinery.

We have shown that the development of threshing machinery did not begin in earnest until in the late fifties. It was then that the vibrator type of machine was brought out and the idea of threshing and cleaning the grain in a single operation was finally worked out. It is interesting to note that at just about this time inventors first began experimenting with the self feeder. Among the first of these early inventors was a man named Samuel D. Reynolds, of Lane, Illinois, who took out a patent, number 21214, on August 17, 1858. It was a crude device which was intended to cut the bands and feed the bundles to the separator at the same time. The details of construction are clearly set forth in the accompanying drawing, figure 42, reproduced from the patent specifications. This was probably the first patent granted in this country relating to self feeders and band cutters. The descrpition of the machine is best given in the words of the patent from which we quote as follows:

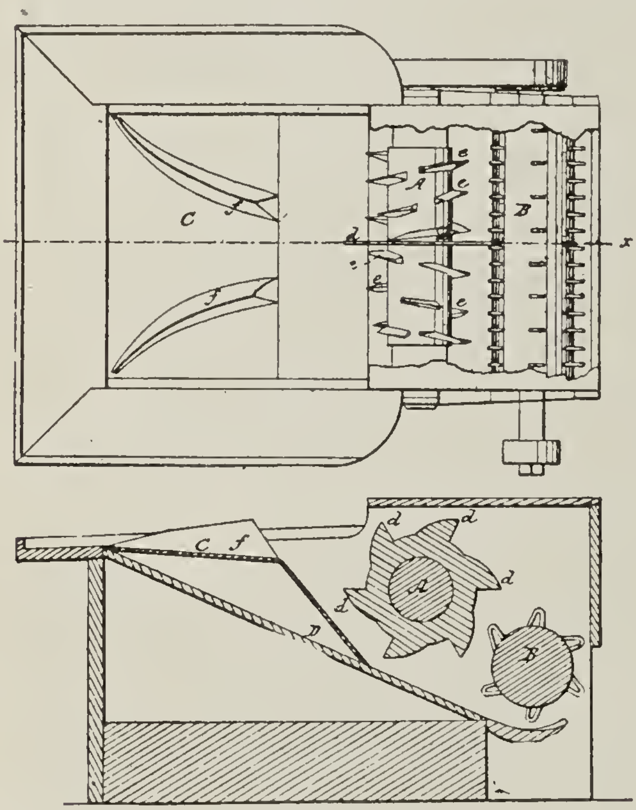


FIG. 42. TWO VIEWS OF S. D. REYNOLD'S BAND CUTTER AND FEEDER.

"In using the threshing machines heretofore constructed, so far as my knowledge extends, the bands of the sheaves invariably have to be cut before their contents can be fed into said machines, which operation adds very considerably to the amount of manual labor required in operating that class of labor saving machinery. To ob-

viate the necessity for the said preliminary band cutting and enable the sheaves of wheat or other grain to be fed directly into a threshing machine is the object of my present invention. This I accomplish by placing in suitable bearings a cutting and spreading cylinder A immediately in front of the threshing cylinder B of a threshing machine and imparting a rotary motion to the said cutting and spreading cylinder by any suitable means, either by banding or gearing.

"The band cutting in my improved threshing machine is performed by a series of blades dd, which radiate from the central portion of the cylinder A, and whose cutting edges may be of such a shape as will enable them to perform their work in the most perfect manner. The instant after the bands of sheaves are severed by the cutting blades dd, the spirally arranged teeth ee, of the cylinder A take hold of the loosened stalks of grain and spread them out uniformly over the inclined apron D, which conducts them to the teeth of the threshing cylinder B.

"The platform C, which receives the sheaves of grain stalks as they are fed into the machine, may be combined with the inclined apron D in such a manner that its position may be so adjusted as to bring it within any desired distance of the blades and teeth of the cylinder A. The sheaves, as they are placed upon the platform C, are guided as they are pressed forward directly to the band cutting blades of the cylinder A by means of a flaring channel formed by the ledges ff, which rise from the upper surface of said platform as shown in the drawings.

"I do not intend to limit myself to a single series of band cutting blades upon the periphery of the cylinder A, for the reason that I may find it expedient to combine several series of cutting blades and spreading teeth with the periphery of said cylinder. The said cutting and spreading cylinder may be used in conjunction with any description of threshing cylinder."

Figure 43 shows a side view and longitudinal sectional view of a band cutter and feeder invented by Isaac H. Palmer of Lodi, Wisconsin, and patented January 26, 1864. Here we have one of the arrangements of a modern self feeder in the raddle which carries the grain from the feeding board to the threshing cylinder. Rotary band cutters, of which there are a number, mounted on a horizontal shaft, cut the bands. This device is driven from the threshing cylinder of the threshing machine in the same manner as at present employed by all the self feeders. We have in this machine of Palmer's some of the fundamental principles of the modern self feeder but the idea is very crudely worked out. There is no governor attachment. The beater HH serves the purpose of feeding the grain from the top of

the bundle first but there are no retarders in the bottom to make this feature really effective.

The first automatic feeder of which there is a record in the patent office was patented in 1858 and described on a preceding page. As indicated therein, the idea of the inventor was merely to construct a machine which would cut the bands and feed the grain to the cylinder. The bundles in the Reynolds feeder were delivered to the threshing cylinder by means of gravity. In the Palmer machine, which was invented in 1864, we see the first exemplification of the raddle system in combination with a rotary band cutter and a distributor.

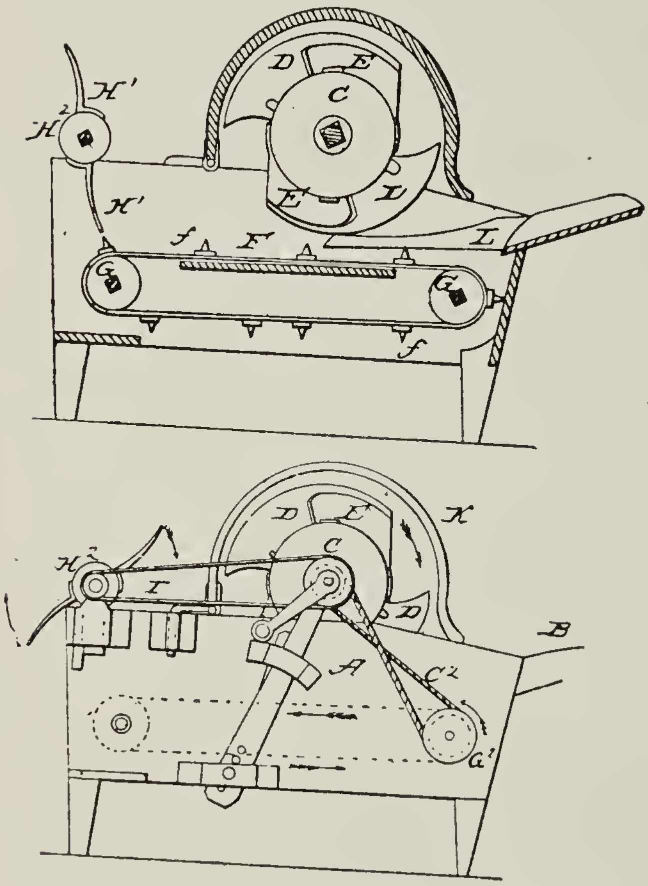


FIG. 43. I. H. PALMER'S BAND CUTTER AND SELF FEEDER, WITH ROTARY BAND CUTTER AND REVOLVING RADDLE.

A number of feeders were invented in the sixties and patents taken out thereon. In several of these machines no raddle was used. The bundle was expected to slide down an inclined pass through a restricted central passage to insure having the band cut by the one central knife and then spread out before reaching the cylinder. Spreaders were devised for spreading the straw equally across the cylinder. These spreaders consisted of various ingenious devices such as discs set eccentrically, spiral wings or webs attached to a central shaft or triangular shaped flat pieces attached to a revolving cylinder having the apex of the angle at the mid-width of the cylinder. In all of the early machines it was deemed essential to have some sort of spreader. The necessity for a revolving raddle, or governors or retarders was not appreciated until thirty or forty years had elapsed. Likewise the necessity for elevating the butts of the bundles or of taking any care as to the height on the cylinder at which the grain was fed were principles not understood for many years afterwards.

As an example of how inventors groped about in the dark, the band cutter and feeder invented by W. U. Hoover and patented in 1865 is a good example. Here we have the raddle placed above a set of in-

clined rollers upon which the bundles passed on their way to the cylinder. The rollers were set at an incline in order that the bundles might all pass centrally over a revolving knife which would cut the bands. After the bands were cut the bundle then was shaken out by vibrating fingers upon a revolving raddle which carried it to the cylinder. The details of construction are clearly set forth in figure 44. It will be noticed that the motion of the feeder could be stopped at any time by disengaging the clutches. This machine, of course, did not prove successful commercially and was never used to any extent.

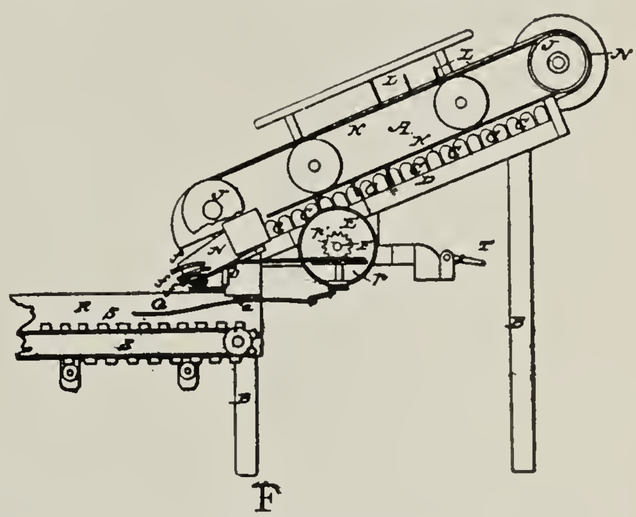


Fig. 44. HOOVER FEEDER, PATENTED IN 1865.

In 1865 Valentine and Ridout of Milwaukee, Wisconsin, took out a patent on a feeding attachment for threshing machines which contained the germ of an idea that is found today in all successful feeders. This feature is the retarder which was designed to operate with a hand lever as shown in figure 45. At the present time the retarder is operated automatically and is placed on the under side of the machine to hold back the bottom part of the bundle. The idea in Valentine and Ridout's invention was in the nature of a hand governor rather than that of the modern retarder and must be so considered. It could be set to allow any given volume of straw desired to pass through the cylinder.

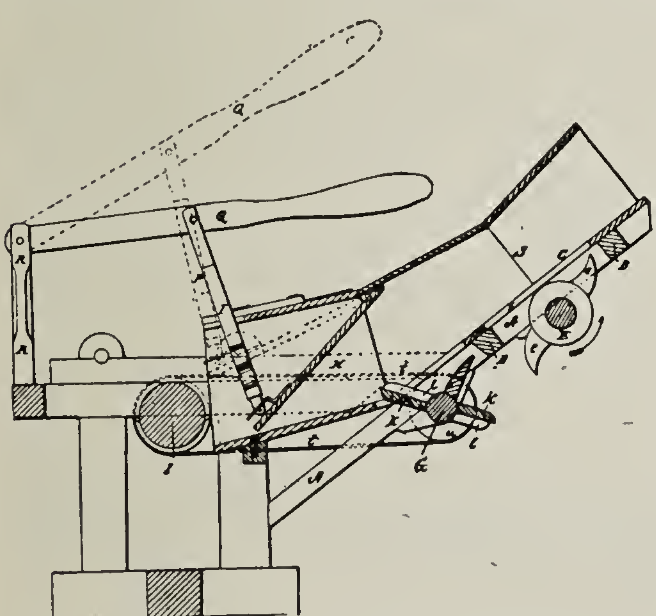


Fig. 45. VALENTINE & RIDOUT'S FEEDER, 1865.

Many people doubtless suppose that the wing feeder is a strictly modern device and was thought of only within very recent years. On referring to the patent office records, however, we find that a man named A. W. Lockhart of Sacramento, California, took out a patent on a wing feeder September 15, 1868. In many respects it resembles the wing feeders of the present time. The wings could be raised or lowered as desired. The

whole machine could be thrown into operation or not by the movement of a lever. The features of this machine are clearly indicated in figure 46.

In 1870, W. H. H. Young of Waverly, Iowa, took out a patent, No. 110,324, on an improved self feeder and band cutter which contained some features new to the art. A sectional view of this machine is shown in figure 47 and it will be noticed that here for the first time provision is made to deliver the bundles to the cylinder by means of a raddle which changes its direction after the bands are cut and which elevates the butts of the bundles before delivering them to the cylinder. The band cutters are merely circular saws. There is a spreader back of the band cutter of the approved form of that time, consisting of a triangular shaped piece of iron mounted upon a revolving shaft. Another feature of this machine which differed from others of that period was that the rear edge of the guide plate T was provided with a flange or cut-off projecting nearly to the carrier belt, which prevented any grain from being carried back and thus lost.

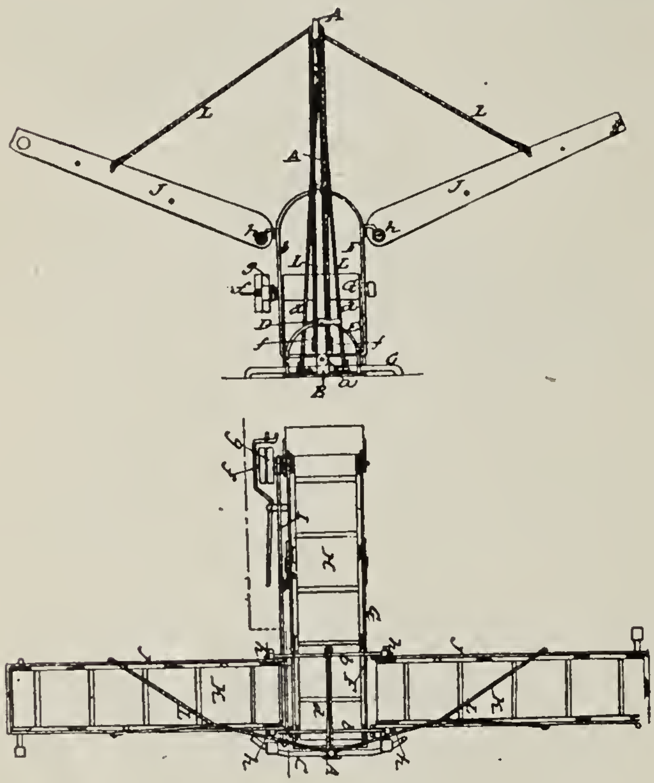


FIG. 46. AN EARLY TYPE OF WING FEEDER.

From 1870 until 1890, a period of twenty years, there was very little development done of any value in connection with self feeders. Perhaps the most important was the work of Mr. F. H. Marshall, already described.

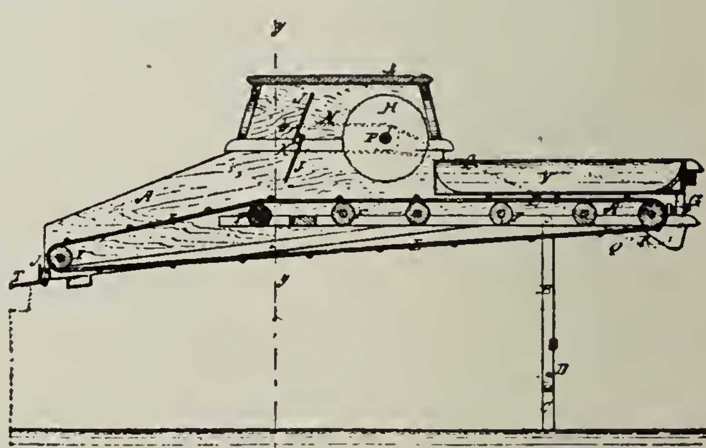


FIG. 47. ONE OF THE FIRST FEEDERS WITH RADDLE BUNDLE CARRIERS.

Beginning about the year 1892, development work and invention took on new life and many patents were taken out. Feeders for the first time were provided with suitable governors that regulated the volume of straw

fed to the cylinder. These were not perfected for a number of years, however. Among the first of the modern machines brought out at this time was the Parsons. It appeared on the market for the first time in 1892. The manufacturers make the statement that about all the competition it had to meet at that time was from hand feeders. It was provided with the same endless carrier or rake used at the present time, the same form of band cutter knife, and the same kind of apron raddle, but aside from these parts it had very little else to identify it with its modern prototype.

Within the next five years following 1892 the governor problem for feeders was pretty well worked out and by the year 1900 there were a large number of feeders on the market, any of which would do the work required of it in a very satisfactory manner.

Quite a number of feeder companies sprang up and as usual with any new business it was overdone. Some of the companies found competition too strong, some were poorly managed or financed, but, most discouraging of all, the thresher companies themselves brought out their own feeders, thus making it difficult to get a market established, no matter how much merit the goods might have.

When we look at a modern threshing machine with all its attachments working smoothly and swiftly in the field it is hard to realize that it has been brought to perfection within such very recent times. The feeder, the wind stacker and the weigher are all very recent. While self feeders were experimented with fifty years ago it was only a dozen years ago that the first variable speed governors were attached. The wind stacker is another improvement that is comparatively recent. Its principles were known many years ago but they were not applied to the grain separator. In fact, the development of the wind stacker business was less a matter of invention than it was a matter of advertising and making the owners of threshing machinery realize that it was such a valuable adjunct to their machines that they could not afford to be without it. It took a number of years to get the trade firmly established.

The years previous to 1894 were years of experimentation and exploitation in the self feeder business. For nearly forty years men had planned and studied and invented but after all very little had been actually accomplished toward getting the machines established as an essential part of the threshing equipment. It is true that most all of the different elements had been invented and experimented with and at that time about all that was needed was a judicious selection and assembling of these elements in order to make a good feeder. The governor was still rather crude but this matter was speedily remedied by Ruth, Parsons, and others. In the year 1894,

the Ruth feeder was patented by David C. Ruth of Halstead, Kansas, and in 1895 the Parsons patents were allowed. Both were subsequently sold to the Maytag Company, by whom they are now built. The preliminary exploitation work had prepared the market for these machines and during the next few years their sales were very large. By the year 1902 practically every point had been thoroughly covered; they were used universally and the struggles of the self feeder were a thing of the past.

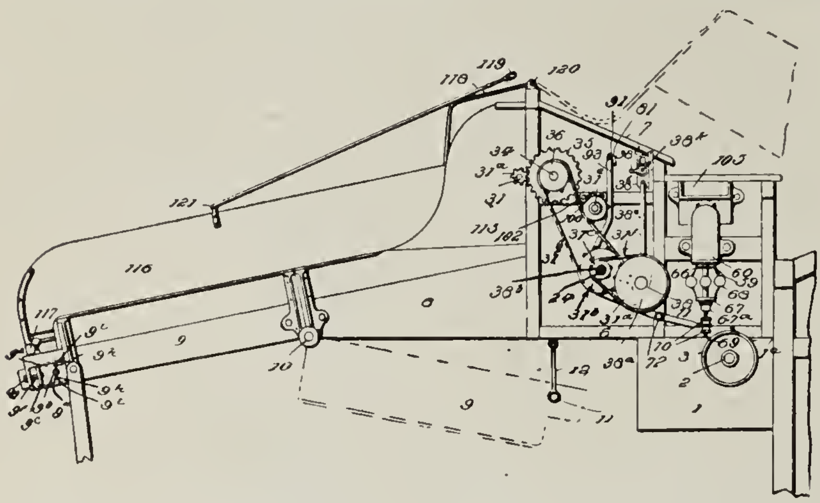


FIG. 48. PATENT DRAWINGS OF THE RUTH FEEDER.

While the different feeders are probably pretty well understood by the majority of thresher trade journals, a description of the governing mechanism of the Ruth and Parsons feeders as given in the patent specifications may prove interesting and instructive to the younger generation.

A reference to figure 48 will show the general appearance of the Ruth feeder and the method of attachment to the separator. Figure 49 shows the threshing cylinder, 56; the feeder cylinder 52; the retarder, 37; the bundle carrier, 23; and the band cutters, 25. If the cylinder travels 1,200 revolutions per minute, the feeder cylinder will make 835, the band cutter 450 and the grain retarder about twenty-two revolutions per minute. The high speed of the feeder cylinder combined with

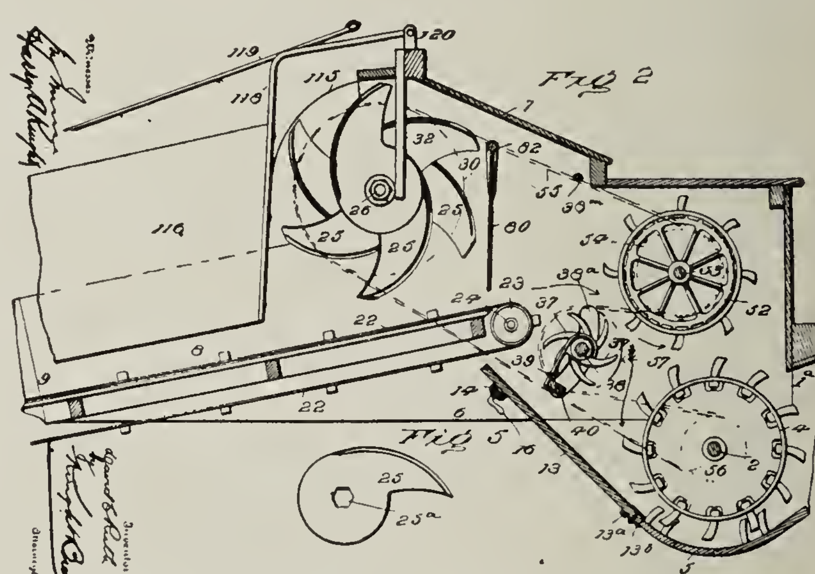


FIG. 49. DETAILS OF RUTH FEEDER FROM PATENT SPECIFICATIONS.

the low speed of the retarder causes the straw to be fed from the top of the bundle. The relative speeds of the different cylinders will be maintained since both the feeder cylinder and band cutter shaft are driven from the threshing cylinder through a belt, 55, which passes

around the idler pulley, 57. The governor, illustrated in figure 50, is driven by means of spur and bevel gears from the feeder cylinder while the retarder and bundle carrier obtain their motion from the band cutter shaft through a system of gears and chains.

As shown in the figures and as constructed, the feeder belt is on the left hand side when you stand at the outer end of the bundle carrier and look toward the machine, while the governor is on the right. A small pinion on the right hand end of band cutter shaft meshes with gear 35 which is mounted on a stub shaft attached to the side of the frame. Sprocket wheel 36, cast integral with 35, drives the sprocket wheel 31b which is mounted on the hub of the disk carrying rollers 27a and attached thereto with a set screw. This disk runs loose on the bundle carrier shaft. Sprocket wheel 31d is keyed to the retarder shaft 38, while sprocket 31c is keyed on the bundle carrier shaft. Connection between the bundle carrier shaft and the sprocket 31b is effected through the dog 26a which is pivoted at 28b. When this dog is in the position shown in figure 50, power will be transmitted from the band cutter shaft to the bundle carrier and thence to the retarder. If, however, the speed of the threshing cylinder falls, the point of lever 71 will engage with the point 74 of the aforesaid dog, throwing it out of the path of the rollers, thus causing the bundle carrier to stop until the excess of grain already delivered is disposed of. Another method of stopping the bundle carrier is provided through lever 93. It will be noticed that this lever is connected at the top with the retarding fingers 80, by means of a short bell crank. When too large a mass of straw passes the band cutter these fingers will be raised and rod 93 will engage dog 26a and stop the bundle carrier just as the governor does. Thus we have two systems of governing in this machine, one through slowing down of the threshing cylinder and the other a volume governor as last described which stops the bundle carrier when the mass of grain is too large.

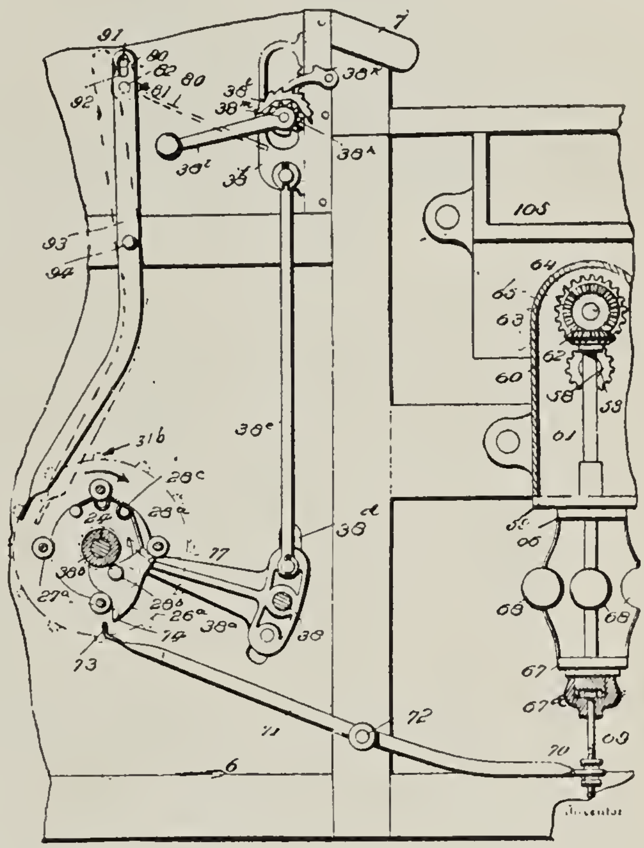


Fig. 50. Governor of Ruth Feeder. Patent Specifications.

The governor of the original Parsons feeder is shown in figure 51, and is a reproduction from patent specifications No. 549,583 granted to G. W. Parsons, November 12, 1895. The governor, which is of the ordinary Pickering type, is driven by means of a bevel gear C3 on the end of the band cutter shaft. The same bevel gear also drives the shaft C which carries the small brush wheel C7, through which motion is transmitted to the bundle carrier by frictional contact with disk C5.

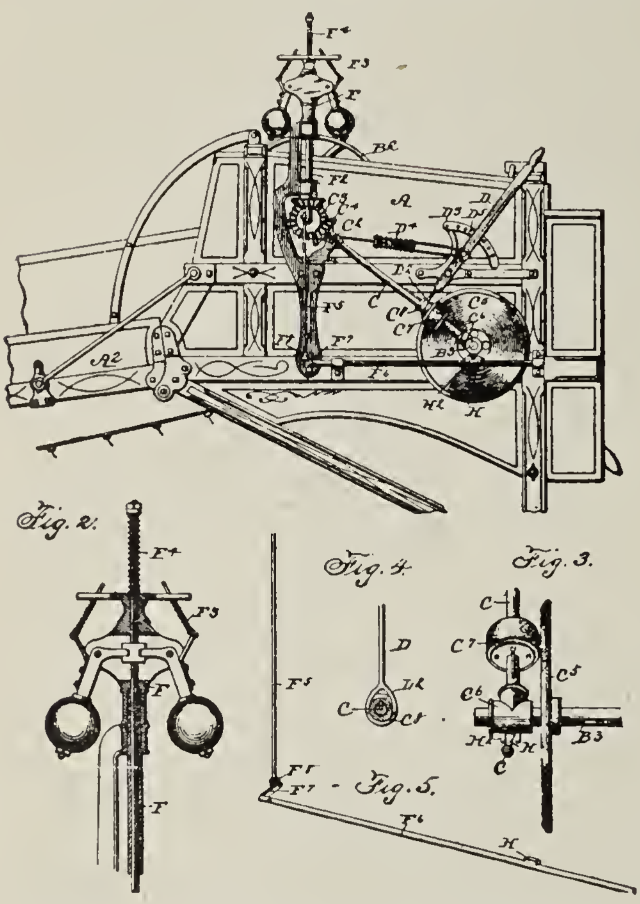


FIG. 51. GOVERNOR OF ORIGINAL PARSONS FEEDER. PATENT SPECIFICATIONS.

It is evident that the speed of the bundle carrier will be dependent upon the distance C7 is from the center of the large disk. This is controlled by means of the hand lever shown. The stopping of the bundle carrier through the action of the governor is accomplished by drawing the small wheel away from the large disk through the action of the bell crank lever and cross shaft F6. The governor is set at such tension that it must attain a certain predetermined speed before the small brush wheel will be forced against the large disk sufficiently to start the bundle carrier. Provision is also made to raise or lower the retarder, thus regulating the distance between it and the feeder cylinder as desired.

Two or three years after the first Parsons feeder was placed on the market, patents were taken out on a new machine which is used more widely than the original. Instead of using a variable speed friction device actuated by a Pickering governor, a new style of governor was invented which will be described presently. In the new machine a rotary band cutter was adopted and a set of feeding forks was placed in front of the feeding cylinder. These forks were made

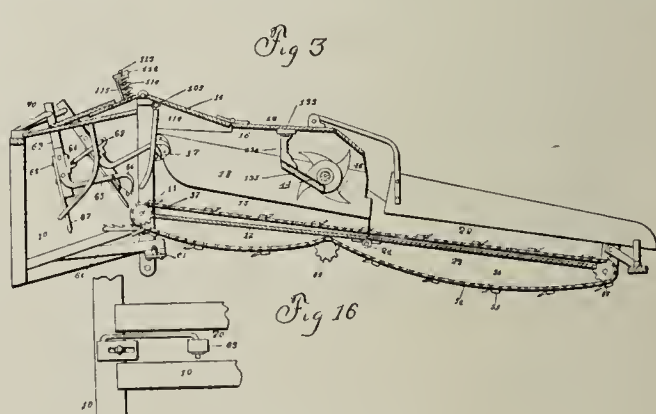


FIG. 52.

adjustable in order that they might be placed close to the cylinder or further away as desired. These are illustrated in figure 52 and an inspection of the drawing will show that they are actuated by means of a multiple shaft driven from the threshing cylinder. On the right hand end of this crank shaft (see figure 53) there is mounted a sprocket wheel, 69, which drives sprockets 99 and 62. By referring to figure 54, we find wheel 71 mounted on a stub shaft on the side of the machine. The main feeder belt from the threshing cylinder passes around this wheel and sets the feeder in operation through sprocket wheel 69, which is mounted on the shaft which actuates the feeder forks.

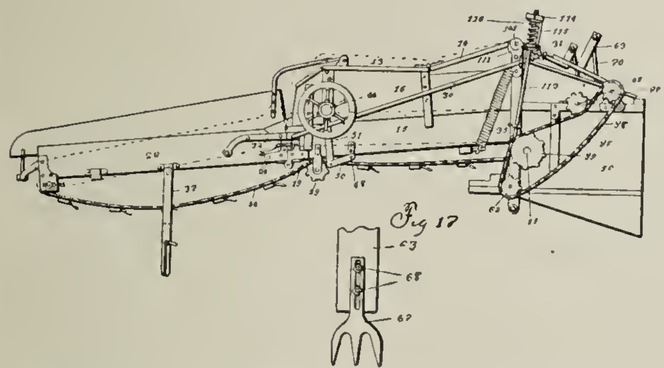


FIG. 53. PARSONS FEEDER, RIGHT SIDE.

The train of mechanism by which the feeder is operated is as follows:

The feeder belt from the threshing cylinder drives pulley 71, which is mounted loosely on stub shaft 72. When the pulley comes up to the proper speed, the governor weights overcome the tension of springs 85 in this wheel and clamp the wheel to a sprocket wheel mounted on the same shaft, the details of which are shown in figure 55. Motion is transmitted from this sprocket wheel to shaft 69, which drives the feeder forks. On the opposite side of the machine (see figure 53) the sprocket chain 98 passes around the sprocket wheel 69, 99 and 62. Wheel 99 drives the bundle carrier and is mounted loosely on its shaft. It is also equipped with a governing device which operates only when the speed has reached a certain predetermined amount. The details of this device are shown in figure 56 and will be presently described.

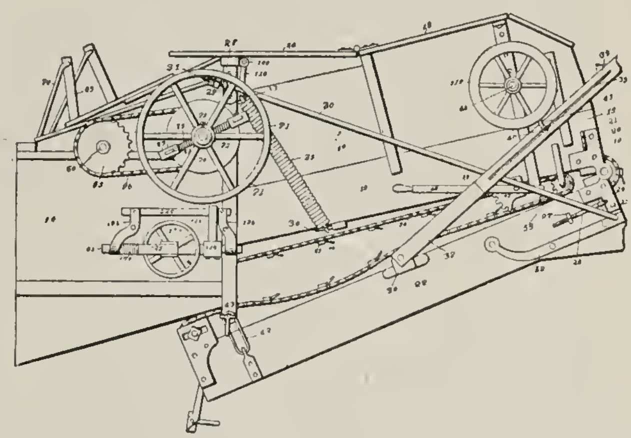


FIG. 54. PARSONS BAND CUTTER AND FEEDER. LEFT SIDE.

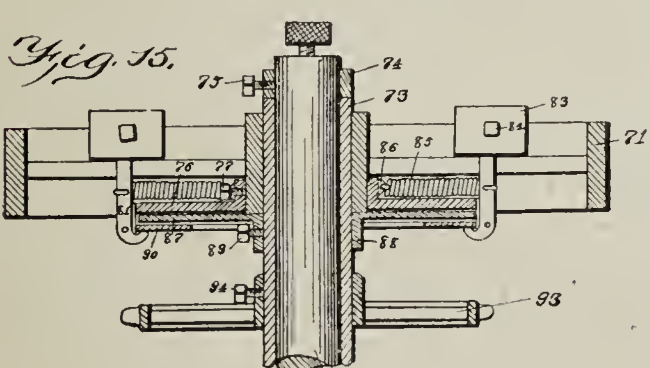


FIG. 55. DETAILS OF NEW PARSONS GOVERNOR.

The main governing device is illustrated in figure 55. It consists of three discs. The inner disc is secured by means of a set screw to sleeve 73. The outside disc is attached to wheel 71. The disc nearest the frame of the machine is held loosely in place. When the speed of wheel 71 reaches a certain velocity, the weights fly outward against the tension of the spring and clamp the three discs together. The frictional contact is sufficient to hold the discs together as one wheel and thus wheel 71 is made to drive the sleeve 73 and with it the sprocket wheel 93, which starts the feeder forks in operation. This governer acts on the same principle as the well known multiple disc clutch used in automobiles.

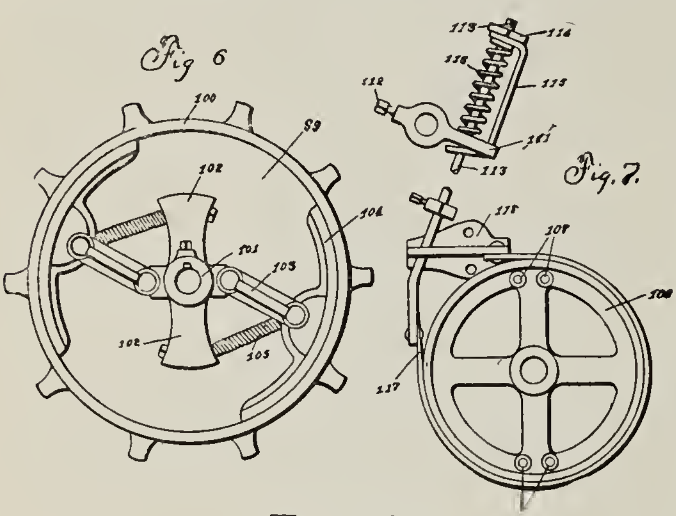


FIG. 56.

The governor which drives the retarders is shown in detail in figure 56. Sprocket wheel 99 runs loosely on shaft 11 and is equipped with an inner rim 100. Hub 101 is keyed to shaft 11. Extension springs 105 force the brake shoes 104 against the rim and cause the sprocket wheel and hub 101 to revolve as one piece and thus drive the bundle carrier. On the same shaft between it and the frame of the machine there is mounted another wheel, 106, which carries two sets of pins, 108, which straddle the links 103. This wheel is mounted loosely on the shaft and is circled by a metal band, one end of which is fastened to a bracket on the side of the machine and the other end to a rod which passes up to the top of the feeder. By referring now to figure 52 it will be observed that there are retarder fingers 110 to prevent too large a mass from passing into the machine. These retarder fingers are attached to the rod which actuates the metal band just described. When so operated, this band acts as a brake and in so doing stops wheel 106 and by so doing withdraws

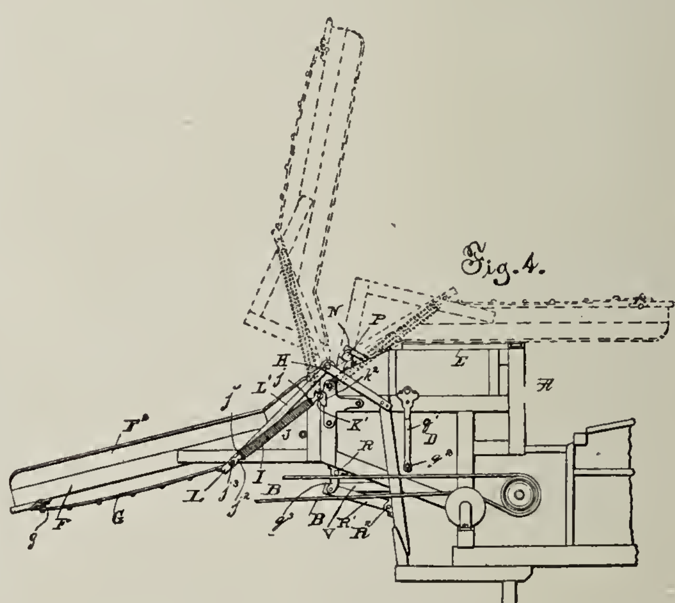


FIG. 57. AVERY FEEDER, SHOWING METHOD OF FOLDING BACK GOVERNOR.

the brake shoes from the rim of the sprocket wheel 99 and thus stops the bundle carrier. In this style of feeder, therefore, we have the main governor attached to the feeder forks and the auxiliary governor or volume governor attached to the bundle carrier. The band cutters are driven from the same belt which drives the feeder forks.

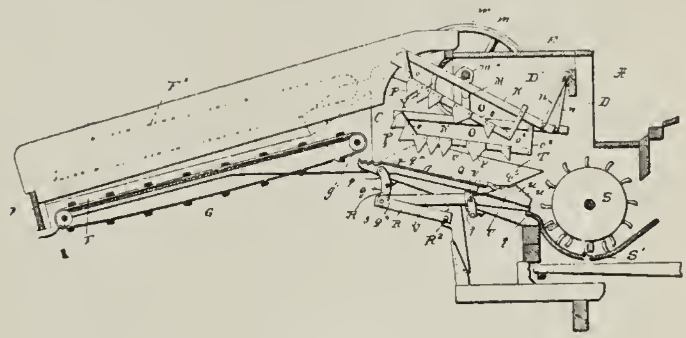


FIG. 58.

Another inventor who has contributed largely to the development of the self feeder is Mr. J. B. Bartholomew, who first filed application for patent in 1898. The feeder which he has developed contains a number of meritorious features, among which may be mentioned the method of attaching to the machine, the folding feature and the governor. In most feeders the bundle carrier table folds under, but in Bartholomew's machine it folds over, as shown in figure 57, and rests, when not in use, on the top of the machine. The band cutters, as shown in figure 58, are operated by means of a multiple crank and are of the reciprocating type. The rear knives travel in the path of a flat ellipse while the forward sections describe almost true circles. This is due to the method of supporting the rear ends of the knife bars by means of a crank. The governor is of the centrifugal type and is very simple. It has been copied quite largely by a number of other builders and inventors. It is mounted loosely on the band cutter shaft and is driven by the feeder belt. On the same shaft and adjacent thereto is the wheel W, figure 57, which is attached to the shaft. When the governor pulley reaches the required speed the weights W4 fly outward and in doing so force the brake shoes against the rim of this wheel and thus start the feeder knives in operation. The same operation also starts the bundle carrier. Consequently in this machine both the band cutter knives and the raddle stop at the same time.

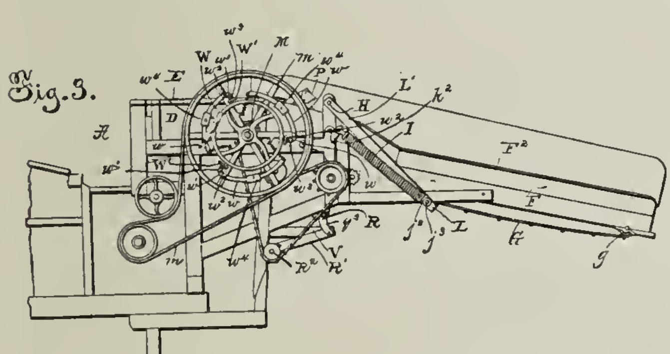


FIG. 59. AVERY BAND CUTTER AND FEEDER. BARTHOLOMEW PATENT.

CHAPTER VII.

THE WIND STACKER AND ITS DEVELOPMENT.

For a great many years the handling of the straw as it came from the machine was one of the hardest tasks around a machine. In the early times, in the days of the old "ground hog" thresher, the straw came out at the rear end of the machine and had to be taken away by men with forks. Later, an elevating straw carrier was invented operated by a chain drive that carried the straw a little distance away and elevated it to whatever height the carrier was built for. This contrivance was awkward and unsatisfactory for a number of reasons. It was easy for the man at the rear end of the machine to carelessly flip the chain off with his fork when he was crowded a little hard or when he got thirsty, as frequently happened. Furthermore, such a straw carrier did not handle the straw very far from the machine and then only straight back. On the big grain farms of the West it became necessary to have five or six men at the rear of the machine to take care of the straw and usually a team to buck the straw away. It was seen that a swinging straw stacker would be an advantage but no one succeeded until in 1882 Reeves & Company of Columbus, Indiana, brought out a carrier, mounted on gas pipe legs from eight to ten feet long, that did the trick. This was a great improvement over former methods and the company enjoyed a large trade. This machine was improved in 1893 by Robinson & Company of Richmond, Indiana, with a carrier that folded back on the machine and that could be supported with ropes. In passing it may be as well to call attention to a machine that Reeves & Company brought out in 1884, mounted on a light wagon truck that carried the stacker.

About the time these improvements were being made in the straw carriers by the firms above mentioned, other men were working on what finally developed into the wind stacker of the present time. The first man to take out a patent on a device of this kind was The Hon. James Buchanan, also of Indiana, and a lawyer. It is said he conceived the idea of his stacker away back in 1879. At any rate he took out a patent in 1884, built a machine which he called his "Cyclone Thresher" and exhibited it at the Indianapolis fair in Indiana. It attracted a great deal of attention. Crowds gathered around and many of the wise ones, and they were in the majority, said it would never prove a success. Many objections were raised. First, it added too much weight to the separator, and second, it required much more

engine power to thresh the grain. These were the principal objections, then others said it wasted grain, that it drew grain out with the straw and threw it in the stack. This was a prejudice that was mighty hard to overcome. It persisted for many years and even yet there are men of the old generation who will maintain in all earnestness that the wind stacker will throw over more grain than it is worth. The fact that whatever grain was delivered to the blower was thrown out violently and was easily felt by a man on the stack probably was responsible for this notion. With the old grain carrier anything that went over was dropped close to the rear of the machine and nothing was known about it until the straw was forked away. With the blower, on the other hand, what little was thrown out made itself evident. Many arguments were advanced to show the wind stacker guiltless. It was demonstrated that a considerable number of kernels might be thrown out every second, in fact, enough to make quite a shower, and yet the sum total in a day's run would amount to only a bushel or two. Another argument that was very effective as showing the blower did not suck the grain over was to throw off the fanning mill belt, run the rest of the machine empty and then lay a five or ten dollar bill on the chaffer, at the same time betting that it would not be drawn over into the blower. It required a long, hard educational campaign and cost a fortune to introduce the wind stacker. As usual, the men who invented the new labor saver got very little out of it.

Mr. Buchanan did very little with his blower. He probably fitted it to a few machines and made a few exhibition demonstrations but did nothing in the matter of founding a business.

His success, however, led a great many other men to study the problem with the result that from 1890 to 1896 a great many patents were taken out. While the wind stacker is one of the simplest devices about a threshing machine, there nevertheless have been more than three hundred patents issued to inventors of wind stackers.

Mr. Buchanan's stacker was quite complete, as will be seen from an inspection of the patent office drawings, figure 60, and the accompanying description taken from the patent specifications, number 297561, issued April 29, 1884.

Figure 1 is a side view of the machine. Figure 2 is a top view of the same; figure 3, a vertical cross-section through the machine on line $x\,x$ on figure 1; figure 4, a horizontal section on a larger scale on line $y\,y$ in figure 1; figure 5, detail drawings and sections through the discharge-tubes; figure 6, a vertical section through the first joint of the discharge-tubes on line $z\,z$ on figure 4, and figure 7 a vertical cross-section through the discharge-tube on line $w\,w$ on figure 6.

The same letters refer to the same or corresponding parts throughout the several views.

B is the receiver, into which the chaff or straw from the threshing-machine is discharged. The fan *b* in the lower part of the receiver B drives the chaff and straw out through the discharge-tubes C C′ C′, when operated by a belt directly or indirectly from the threshing-machine or engine. The discharge-tubes C C′ C′ are secured to and operated on the truck and frame A by fingers *s s s* or a flanged band overlapping the shoulder or ring G, to which the first joint C of the discharge-tube is riveted, said ring G resting on anti-friction balls or rollers *g g*.

To the front of shoulder or ring G is secured the wire chain or rope K, which passes around at each side and to rear end of tube C, and through the pulleys P and P′ back upon the shaft I, in such a manner that when the rope is winding up on one side of the shaft it unwinds on the other side, causing the discharge-tubes C C′ C′ to turn. The discharge-tube will turn in one direction until either of the arms *m m* shall have moved around to the center of the machine, when it will strike the arm *j* on the shifting-rod J and throw the belt O from one pulley to another, which will, by means of a crossed belt, reverse the motion of the shaft I and cause the discharge-tubes to move in the opposite direction until the arm *m* on the opposite side of the discharge tube shall have moved around, and by striking the arm *j* on the shifting-rod J, thrown the belt O off from the pulley onto the one from which it came, and so on as long as the machine is operated.

In 1891, Mr. A. McKain of Indianapolis, seeing the possibilities of building up a profitable business in the wind stacker business, interested some Eastern capitalists and organized the Indiana Manufacturing company. This company acquired the Buchanan patents in 1893, paying the inventor one thousand dollars per year royalty, and all the other patents that had been issued up to that time and began their campaign of educating the threshermen of the United States to the value of the new machine. During the first two years the company was a heavy loser. They encountered the most determined opposition from threshermen, from manufacturers and from farmers and it required all the resources at their command to turn the tide. For one thing the cost, which was two hundred fifty dollars, was rather high for those times and added to that was the expense of having the separators shipped to Indianapolis and back to have the new machines fitted. In spite of all the difficulties, the wind stacker began to make friends and the business began to pick up. Among other schemes of getting the business started they tried the plan of sending a crew of men into the field to put on machines in various parts of

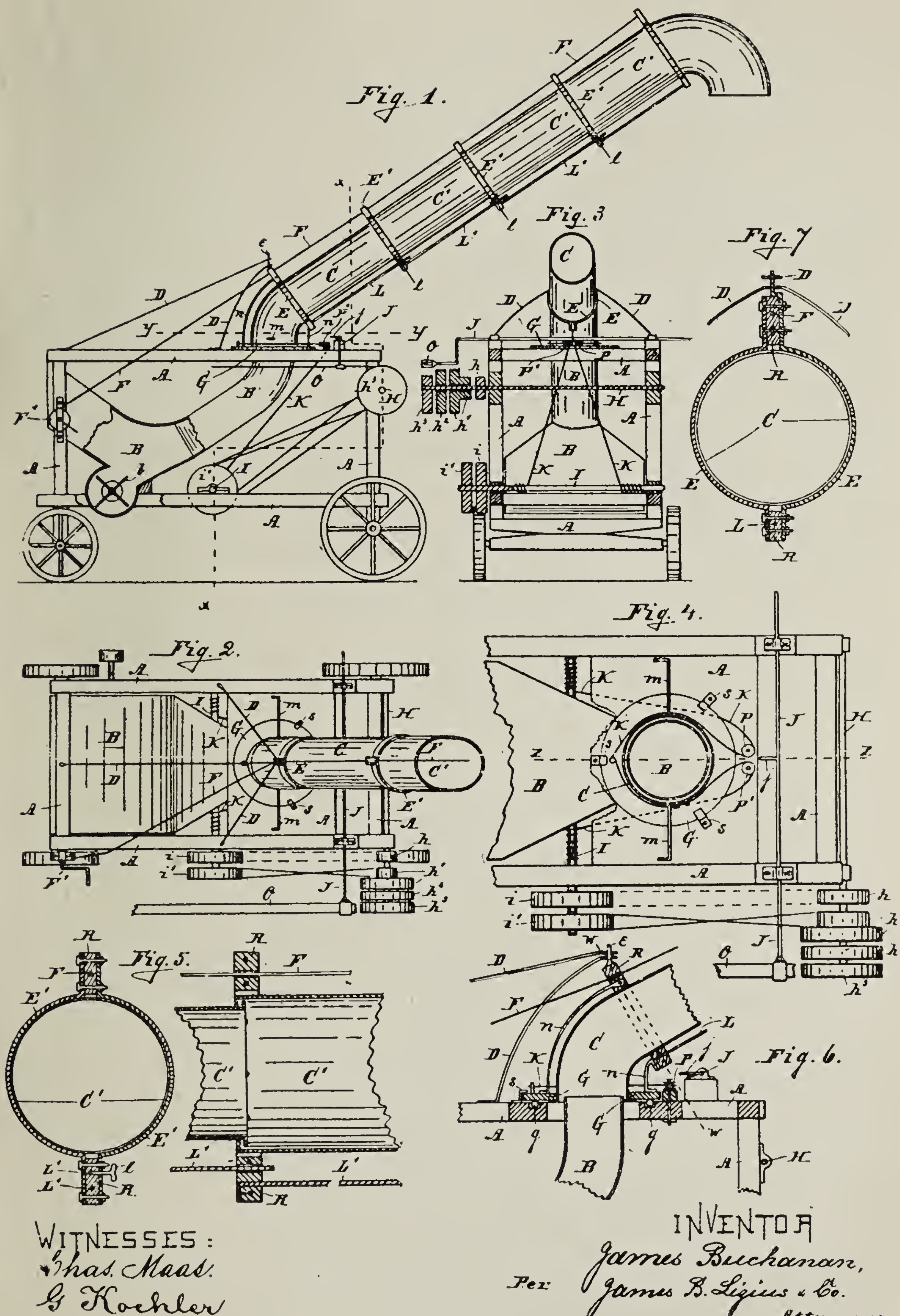


FIG. 60. THE ORIGINAL WIND STACKER PATENT.

the country, starting them in Texas and sending them north as the season advanced, until when it closed they were as far north as Manitoba. In this way they gave practical ocular demonstrations in every one of the great Western grain growing states.

The next season orders began to come in in sufficient numbers to insure the success of the new undertaking, the thresher companies began to make provisions to add the stackers at the factory and changes were made in the design of both stackers and separators enabling a stacker to be attached by any handy man in the field. The fruits of the extensive advertising carried on by the Indiana Manufacturing Company now became evident and they gradually went out of the manufacturing business and began to sell on royalties, charging the various companies thirty dollars for the privilege of using their patents. The business by this time was highly profitable and the faith of the early promoters was seen to be fully justified.

Much has been said of the monopoly enjoyed by the Indiana Manufacturing Company of the wind stacker business, a monopoly which they were enabled to enjoy by buying all the patents having any material bearing on the business as fast as they were issued, but there is here, as in most businesses of a similar nature, another side to be considered. They quickly put the wind stacker before the public, educated the public to its benefits and on account of its merits doubtless saved to the public more than they ever were paid for. Besides, they spent money royally and helped the entire thresher business from a manufacturer's point of view, by their extensive advertising. Moreover, they were continually at law in an endeavor to protect their own claims, and all this cut heavily into the profits.

Even with all their endeavors to maintain a complete monopoly they were not entirely successful. Quite a number of new companies sprang up and succeeded in doing a considerable business, among which may be named the Russell Wind Stacker Company, The Maplebay Company, and the Fosston Wind Stacker Company.

There is much to be said in favor of the monopoly of the wind stacker business by the Indiana Manufacturing Company: In the first place they spent enormous sums of money educating the farmers and manufacturers to the use of the stacker and at the same time carrying on a great deal of experimental work. After the demand was created, and it was created against tremendous opposition, they allowed the various tractor companies to build wind stackers on commission, charging, as stated previously, thirty dollars for each stacker. They had been careful to purchase all the patents bearing on the subject and consequently their licenses were protected by all of the patents that had been issued. This undoubtedly saved them and

their customers a great deal of litigation and at the same time put them in possession of every detail of improvement that any of the inventors had conceived. Such a policy as this, while tending toward monopoly, has the advantage of developing the machine in the quickest possible time.

It is a matter of record that within a very few years after the stacker was invented it reached its present stage of perfection, thus proving that the policy adopted worked to the advantage of the art. There may have been some evils in connection with the business. Possibly prices were maintained at a high level but we doubt if it made the price of the complete rigs more expensive. Every manu-

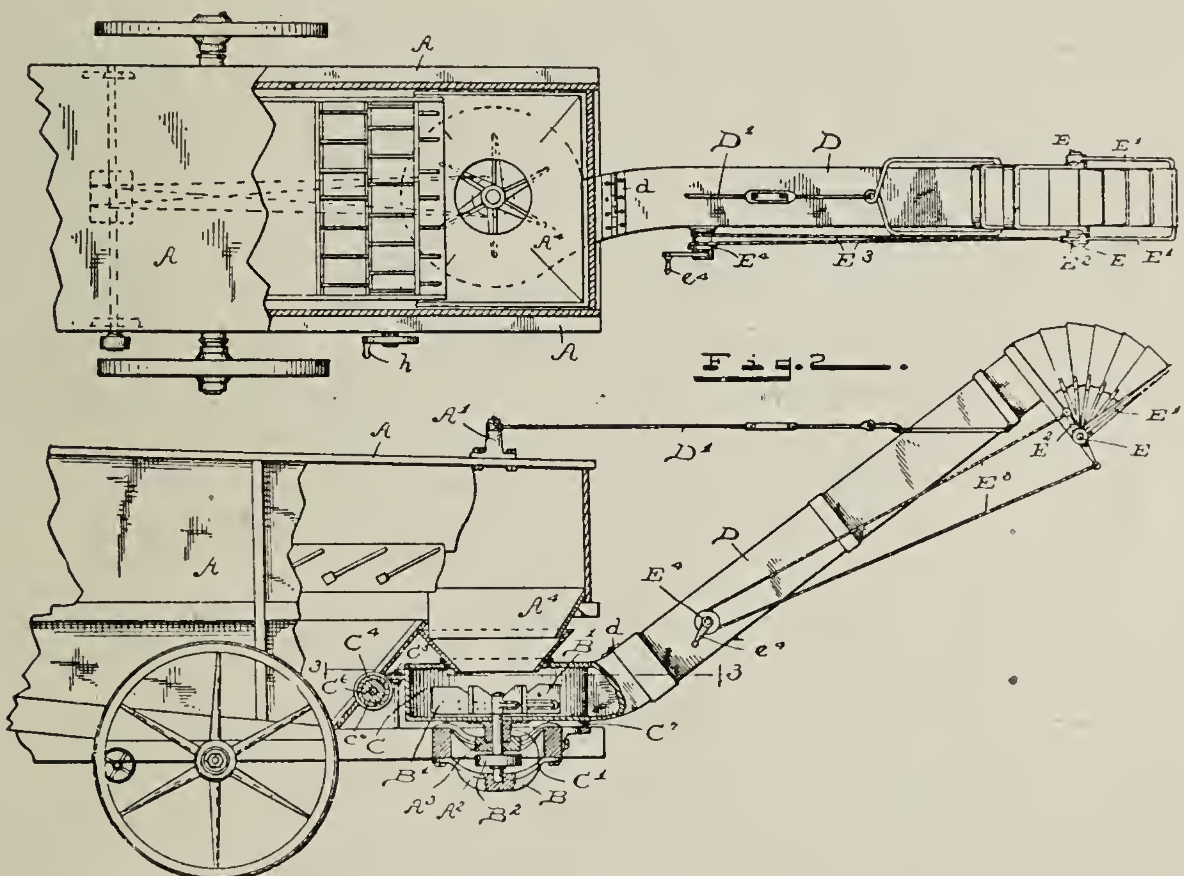


FIG. 61. THE NETHERY WIND STACKER, ONE OF THE ORIGINAL PATENTS.

facturer knew that his competitors had to charge exactly the same price, two hundred fifty dollars, for a stacker, and if he wished to meet competition he could do so by cutting his profits on some other part of the outfit, as many of them did.

We are not offering this argument in defense of monopoly, but merely give the facts as any historian should in reviewing the subject.

The next patent after the Buchanan patent of importance was granted to J. W. Nethery, March 21, 1893, serial No. 493734. This machine, illustration of which appears in figure 61, differed from the Buchanan patent in a number of important details. In the first

place, the fan was placed horizontally and the straw passed directly into the fan casing through a chute especially provided for that purpose. This principle of having the straw pass directly into the fan has come into quite general use and is of the type of stacker which has been adopted by a large number of the thresher companies. None of them at the present time, however, place the fan in a horizontal position. Six patents in all were granted to Mr. Nethery covering various details relating to the construction of the straw delivery tube and its rotation and elevation. In a patent taken out in 1894 Mr. Nethery makes use of a worm and worm wheel at the base of the delivery pipe to rotate it in a horizontal direction. In other patents he followed Buchanan's ideas in placing the fan back of the straw chute instead of compelling all the straw to pass through the fan. The possession of these patents and the Buchanan patent secured the Indiana Manufacturing Company in their rights and every company is still paying royalty.

A large number of inventors contributed to the perfection of the wind stacker and none of them have more patents to their credit than F. E. Landis of the Geiser Manufacturing Company. S. D. Felsing and E. D. Gustafson of Maplebay, Minnesota, were the inventors of the Maplebay wind stacker. Their first patent was granted in 1897. A company was organized to build the stackers and a considerable business was developed. The factory is located at Crookston, Minnesota, and is still doing a good business. Although there are six independent stacker companies all of them that manufacture wind stackers still pay royalty to the Indiana Manufacturing Company, although they are using some of their own patents covering certain details of construction. In addition to these independent concerns most of the larger thresher companies make their own wind stackers. In 1895 A. A. Russell and H. A. Russell took out patents on a stacker and organized a manufacturing company. They are still doing a thriving business under the name of The Russell Wind Stacker Company, of Indianapolis. The Fosston Manufacturing Company, St. Paul, Minnesota; Heineke & Company, of Springfield, Illinois; The Pella Stacker Company, of Pella, Iowa; and the Sattley Stacker Company, Indianapolis, are the six companies still engaged in the stacker business. Heineke & Company and the Sattley Stacker Company both manufacture the Sattley stacker, which is made in two styles, one an all raddle machine, and the other a combination blower and raddle. In the latter the straw is first elevated by a blower a part of the way and delivered to the swinging raddle which conveys it to the straw pile. The Pella Stacker Company make only a raddle carrier.

Mr. J. B. Bartholomew was another inventor who aided in the development of the stacker. He began experimenting in the late '90's and made application for his first patent in November, 1898. In his machine the stacker fan is placed at the side and the straw is delivered into the fan by means of an especially constructed chute. By placing the axis of a fan in a horizontal position he is enabled to

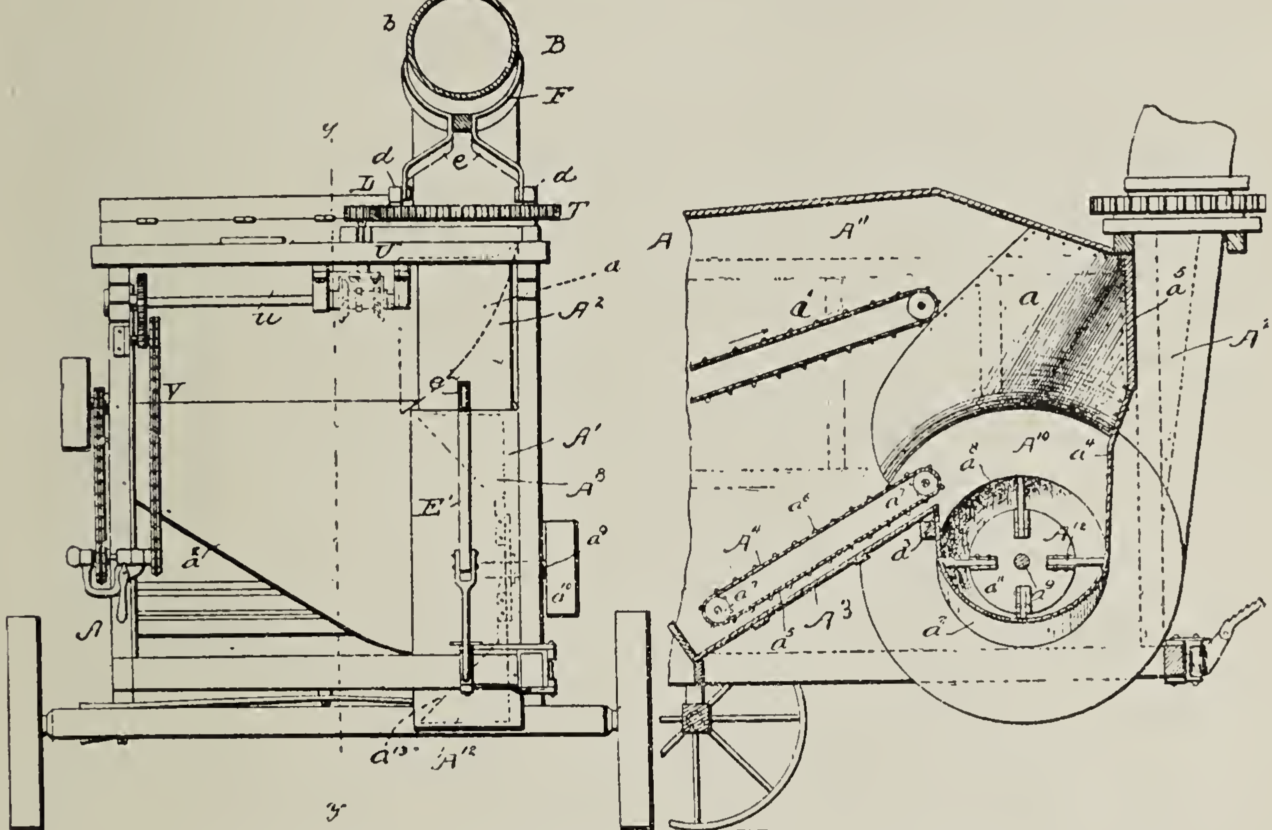


FIG. 62. THE BARTHOLOMEW WIND STACKER.

drive with a straight belt, thus avoiding beveled gears or quarter turn belts. He also devised a mechanism for swinging the straw chute automatically backward and forward together with special means for telescoping the stack. The stackers built for the Avery Company's separators all contain the Bartholomew improvements.

CHAPTER VIII.

CLOVER AND ALFALFA HULLERS.

Clover Hullers.—The threshing of clover, alfalfa and other small seeds is much more difficult than threshing the coarser grains such as wheat, barley, oats and rye. These grains are easily separated from the husk and require comparatively simple threshing devices to effect complete separation. With the small seeds, however, there is a heavy seed pod in which the seeds are buried deeply, which fact taken in connection with the further fact that the seed is so very small makes a different sort of treatment imperative in order to do good work.

On one of the opening pages it was stated that there were two methods of threshing in common use, one in which the grain is beaten out of the husks and the other, a rubbing process for effecting the same result. In all of the coarse grain threshers which we have discussed in these pages, and, in fact, that are now on the market, the beating process, which is a modification of flail threshing, is the one adopted. It may be as well in passing to call attention to the fact that there is also a slight rubbing action between the teeth of the cylinders and concaves even in these threshers. The principal action, however, is that of beating the grain out of the husks by the violent blows delivered by the rapidly moving cylinder teeth. The concave teeth act principally as retarders and serve as buffers for the straw.

In the case of clover threshers, on the other hand, the most successful machines depend upon the rubbing action of the huller cylinder to break up and open the seed pods in a manner to be presently described.

The machines now on the market for hulling clover and alfalfa may be roughly divided into two classes, viz., those especially designed for that particular purpose and those that are primarily designed as coarse grain threshers, but are provided with certain attachments to convert them into hullers. The converted machines are used in many places where there is only a limited amount of clover grown and it would not pay to invest in a machine especially designed for that kind of work. It is only fair to say also that in general these attachments do tolerably good work, especially if the straw is dry and in good condition for threshing. They are not as effective, however, under all conditions as the regular hullers and do not do quite as good or as clean work. Nevertheless, they serve a useful purpose and a great many bushels of seed are recovered which otherwise would be

lost. While some of these converted machines are mere makeshifts there are others that compare very favorably with the regular machines designed for the purpose. While it is not our purpose to draw comparisons between the machines turned out by the different manufacturers, we will endeavor to point out the different methods employed to do the work and allow the reader to draw his own conclusions. To begin with we will take up a discussion of some of those machines designed especially for hulling.

The history of the development of hulling machinery began about 1850, about seventy-five years after men began seriously to study the threshing of coarse grains. At this time the fundamental principles of threshing the grain from the straw were pretty well worked out, and the principles of separation after passing the cylinder were engaging men's attention. In the next twenty years these were pretty well worked out, and then began that series of inventions embracing the self feeder, wind stacker and other accessories which have been made the subject of a number of previous pages.

The one man who did more than any other to discover the laws governing the hulling of clover and invent the necessary machinery to carry out his ideas was Mr. John Comly Birdsell, a farmer and the son of a farmer who, when he began his labors as a young man, lived in the township of Rush, Monroe county, New York. Mr. Birdsell was of Quaker ancestry, and like most people of that faith did his work conscientiously and faithfully. He was a good farmer and studied farming with the same intelligence he afterward bestowed upon the problems of hulling machinery. While engaged in farming he studied mechanical problems and used, so the story goes, to thresh for his neighbors using many of his own inventions for doing the work. In his investigation of the problems involved in hulling machinery he had the advantage of what for that time was a fairly good education, which included, in addition to the regular public school course, two or more terms in a local academy.

After working a number of years he concluded to build hullers exclusively and in 1855, after his patents were allowed, organized a company with himself as president to carry on the business. For seven years he remained at Henrietta, his old home, building machines and improving them. Since the principal market for his machines was in the states bordering on the Ohio River and the Great Lakes, he decided to move and so in the year 1863 he sold his farms and moved his plant to South Bend, Indiana, where it still remains. Here he continued in business until his death in 1894. After the success of the machines was thoroughly demonstrated, he passed through the usual trying ordeal of defending his patents and getting the business

firmly established. This he finally accomplished with the aid of his four sons, V. O. Birdsell, B. A. Birdsell, J. B. Birdsell and J. C. Birdsell. Two of the sons, J. C. and B. A., are still the principal officers of the company. Their plant covers a large area of ground and they do a large business not only in clover and alfalfa hullers but in high grade wagons and manure spreaders.

While we have given considerable space to the growth and development of this company, we feel that we are justified in doing so inasmuch as it was mainly through their efforts and the genius of the elder Birdsell that clover hulling machinery was invented and brought

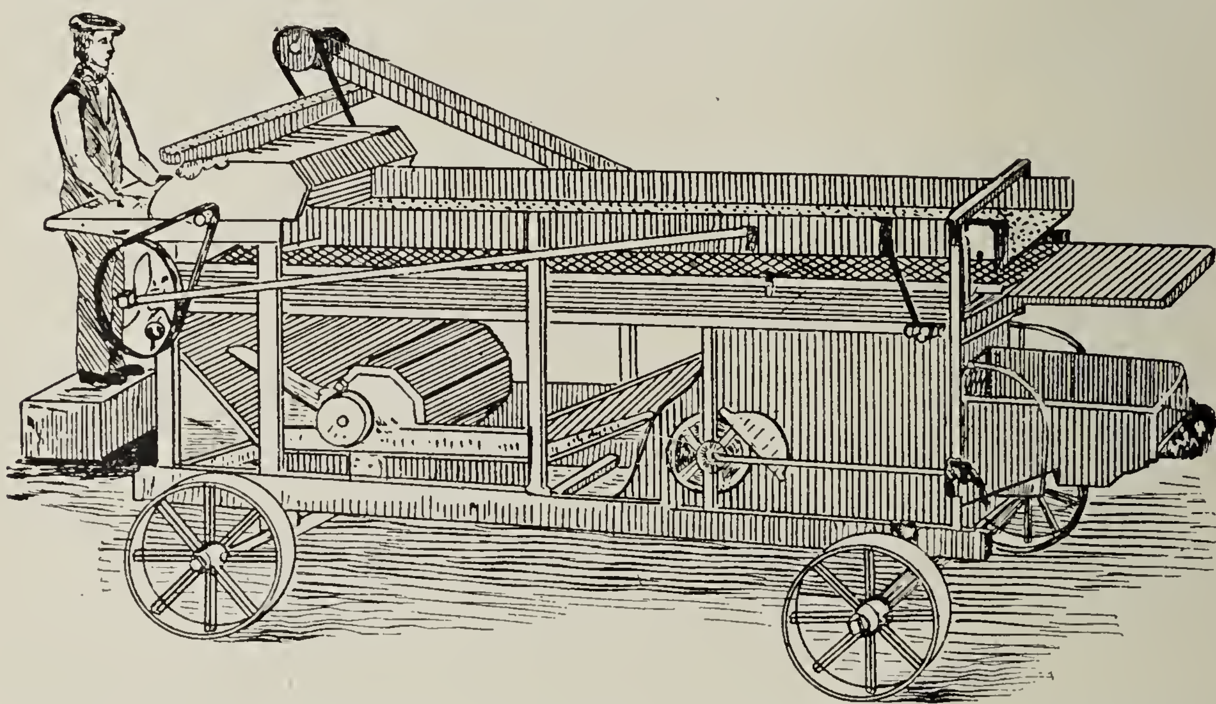


FIG. 63. PEN DRAWING OF THE FIRST COMBINED BIRDSELL THRESHER AND CLEANER.

to its present state of perfection. Every principle found in any of the clover hullers at the present time can be traced back to the efforts of the Birdsells.

Figure 63 is from a pen drawing said to represent the first combined huller thresher and cleaner built by John Comly Birdsell. Compare this with the present style of machine shown in figure 64.

An inspection of the latter figure will show that there are two cylinders, first a stemming cylinder which breaks the seed pods from the straw and perhaps threshes out a part of the seed, and second a hulling cylinder that removes the seeds from the pods. The first cylinder is provided with spikes or cylinder teeth of the usual construction found in coarse grain threshers, while the second cylinder, in place of having spikes, is covered with a rasp, nailed to a wooden drum. Surrounding the second cylinder there is a heavy casing

also covered with a rasp on its inner surface whose points are directed toward the incoming chaff and seed pods. The cylinder is set eccentric in this casing, thus leaving a space of several inches where the chaff enters and a very narrow space for the chaff and threshed out seed to escape, which is not much more than twice the diameter of one of the seeds. It is in passing between the cylinder and this casing that the rubbing takes place, and where the seed pods are thoroughly disintegrated. This device provides as near an approach to the action of the hands in rubbing out the seeds as it is possible to obtain by mechanical means.

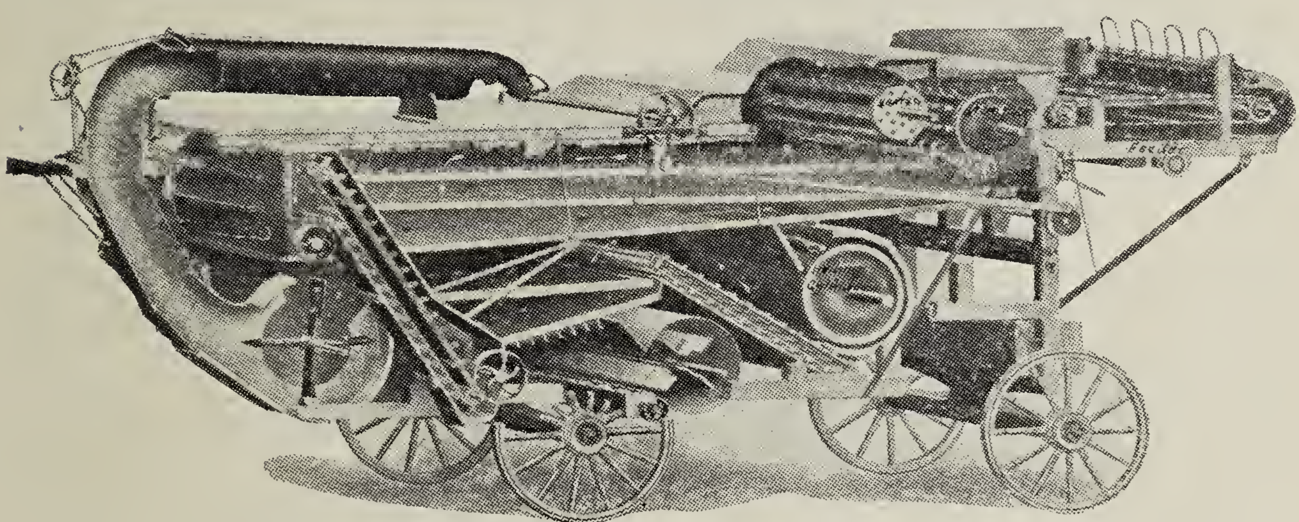


FIG. 64. SECTIONAL VIEW OF PRESENT BIRDSELL HULLER.

In all of the clover hullers designed especially for hulling clover seed two cylinders are provided, one to separate the seed pods from the straw, the other to rub the seed out of the pods. The first, or stemmer cylinder as it is called, is of the ordinary spiked tooth construction, such as is used in the threshing of coarse grains. The other is built in several different styles which will be described presently. The hay is fed to the stemmer cylinder just as it is raked up out of the field by means of a self feeder of the usual type except that it is not equipped with band cutters since clover hay cut for seed is not bound. Back of the threshing cylinder there is usually, but not always, a beater, and underneath, a set of straw racks which separate the coarse material from the seed pods and chaff. The latter drop through the rather coarse rack and are carried back by another rack to the hulling cylinder.

The arrangement of these two racks and the relative position of the two cylinders are shown in figure 64. In the Birdsell and Rumely hullers, which are very much alike, the cylinder is covered with a hardened steel rasp which can be renewed when worn. This rasp comes in long strips and is nailed both to the cylinder and to the

concaves. Figure 65 shows how it is prepared. As will be seen from the illustration, it is made on a special machine from strap steel about one-eighth of an inch thick and an inch and an eighth wide. Figure 66 is an illustration of the hulling cylinder with concave dropped down as used in the Rumely machine. Referring again to figure 64 it will be seen that the unthreshed seed pods and chaff are taken into the hulling cylinder at the top and forced between the concaves and hulling cylinder, by means of a beater. The direction of rotation of this cylinder is the same as that of the threshing cylinder. It runs at a speed of about 850 revolutions per minute while the stemmer cylinder makes about 1,100 revolutions. The fine chaff and seed are delivered to an elevating raddle which carries the grain to the fanning mill. The seed as it comes from the mill is delivered from the seed spout to the recleaner by an endless chain supplied with buckets to hold the seed. The recleaner is a small fanning mill on the outside of the machine.

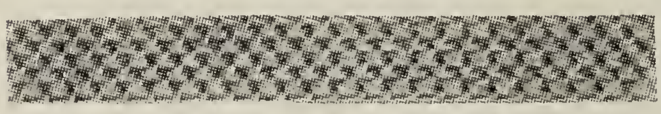


FIG. 65. SECTION OF RASP USED ON HULLER CYLINDERS AND CONCAVES OF BIRDSELL AND RUMELY MACHINES.

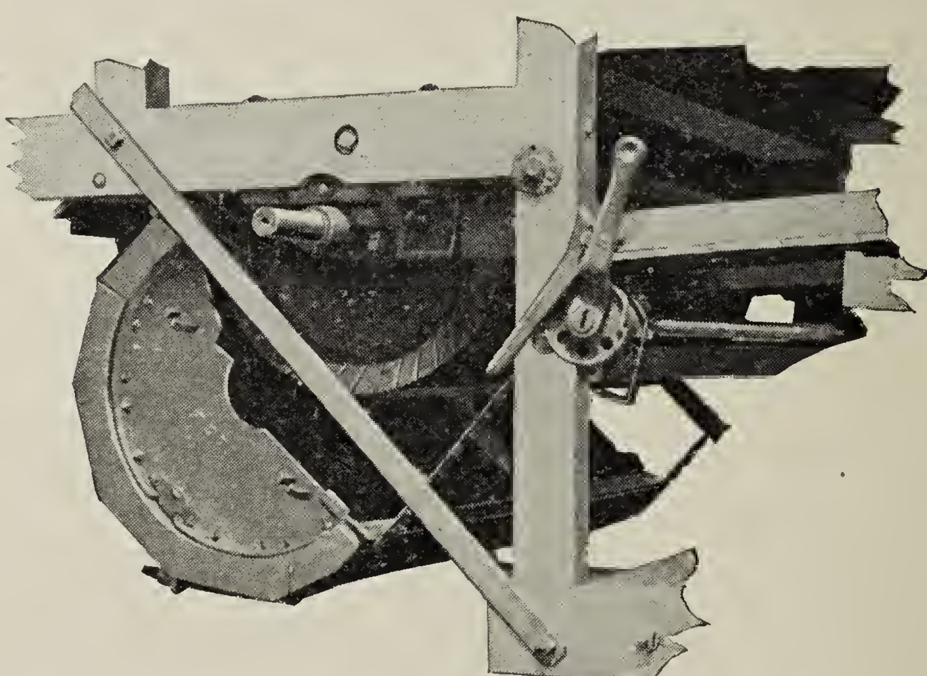


FIG. 66. HULLER CYLINDER AND CONCAVE OF RUMELY CLOVER HULLER, SHOWING METHOD OF DROPPING THE CONCAVE.

Figure 67 is a sectional view of the recleaning mill used on the Rumely huller. This little mill takes out all the weed seeds, chaff and other foreign matter and delivers the seed in a sack ready for market. The unthreshed heads and parts of seed pods are caught

in the tailings elevator and returned to the upper straw rack and from there carried to the hulling cylinder. This brief description applies equally well to the Rumely or Birdsell hullers. It should be observed further that between the first straw rack and the little rack which carries the chaff to the hulling cylinder there are intermediary racks through which the chaff must pass. This rack completes the separation of the coarse material from the chaff.

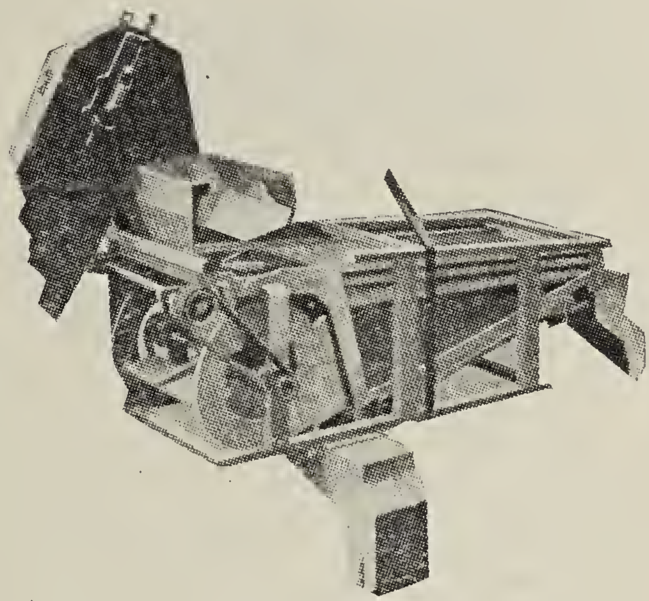


FIG. 67. SECTIONAL VIEW OF RE-CLEANER USED IN RUMELY HULLERS.

Several companies are building hullers fitted with a huller cylinder provided with spikes working inside of a concave also provided with spikes. Figure 68 is a sectional view of one of these machines built by the Geiser Manufacturing Company. As will be readily seen from the illustration, there are a large number of corrugated teeth in both the huller cylinder and the concaves which nearly surround it. In this machine the straw is delivered from the stemmer cylinder upon the

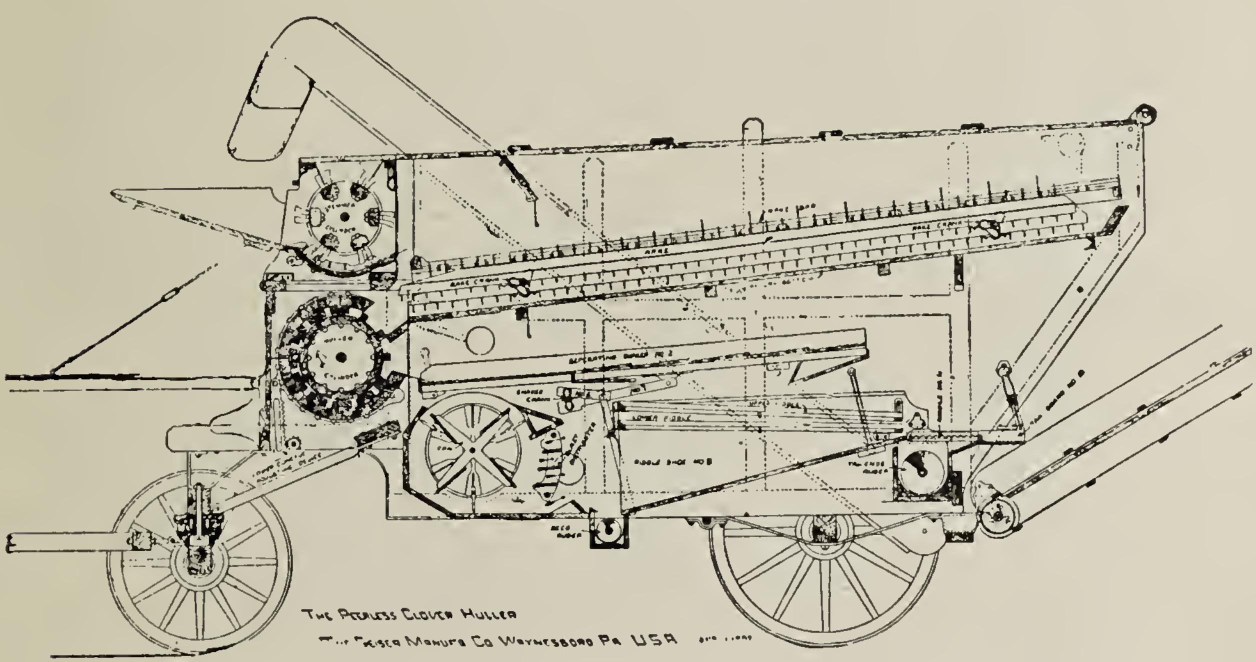


FIG. 68. SECTIONAL VIEW OF GEISER CLOVER HULLER.

first set of racks which separate the seed pods and chaff from the coarser material. This chaff is carried back on a grain return bottom to the huller cylinder. After passing around the huller cylinder

the chaff and seed are delivered to a separating shaker through which a blast of air passes. The seed falls through the riddles of the mill and the chaff is blown back to the rear of the machine.

Figure 69 represents still another type of huller cylinder found in the Aultman & Taylor huller. In this machine both the hulling cylinder and concave are filled with square steel brads which are driven into hard wood staves through suitable openings in a sheet metal covering. The exposed ends of the brads are almost square. The concaves can be adjusted as closely as desired to the cylinder so there is no possibility of pods passing through without being torn apart. A glance at the various illustrations will show that there are three types of hulling cylinders, one in which rasps are used, another using cylinder spikes, and a third using brads. In addition to the clover hullers designed exclusively for that purpose, there are a number of combination machines on the market

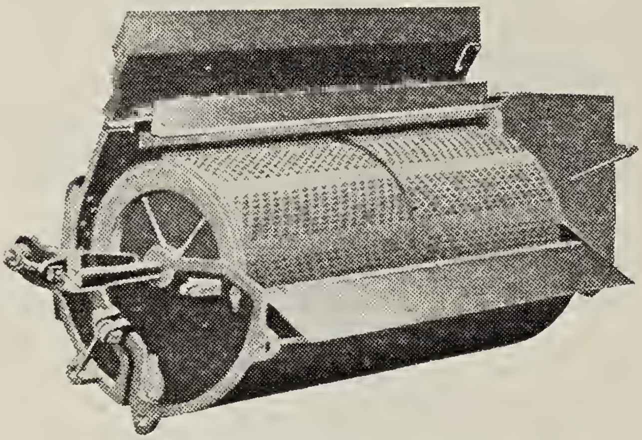


FIG. 69. HULLER CYLINDER OF BRADDED STYLE USED BY AULTMAN & TAYLOR CO.

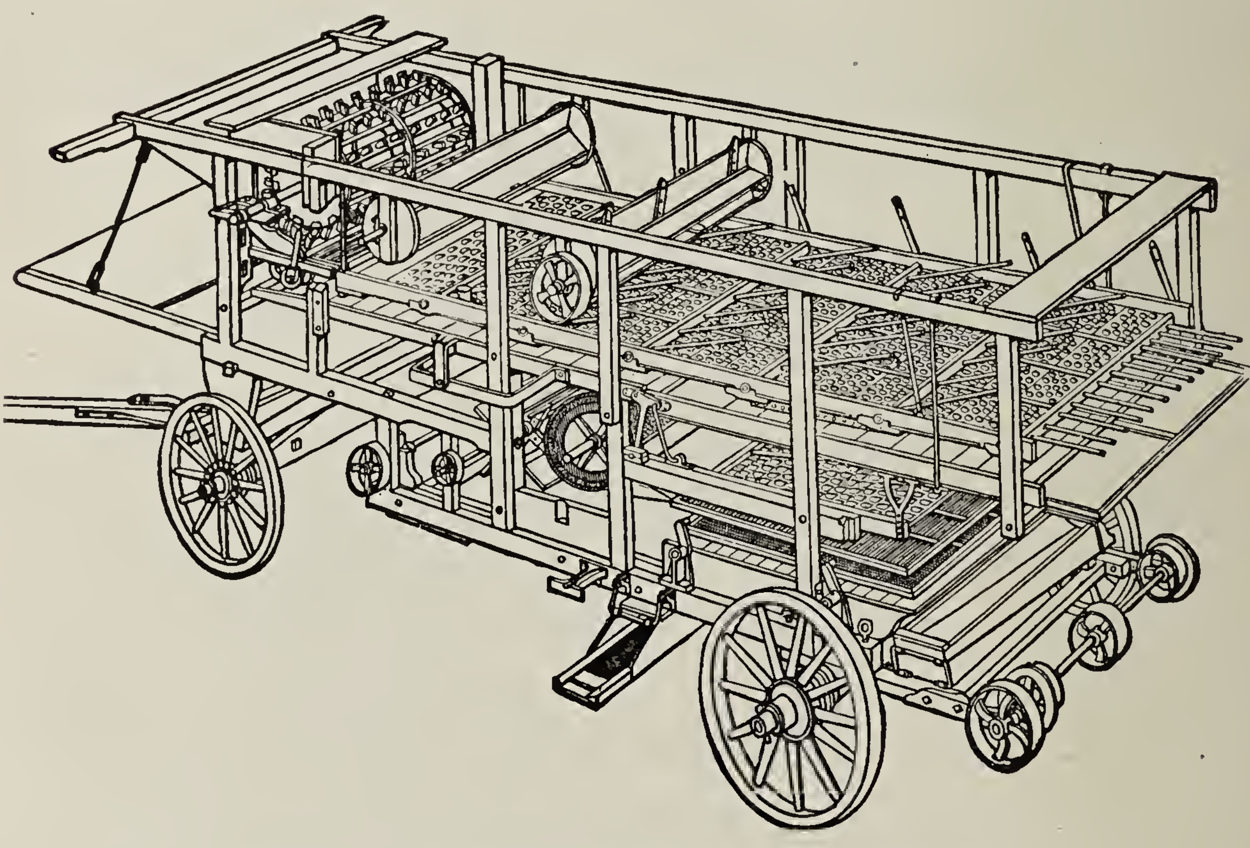


FIG. 70. WESTINGHOUSE CONVERTED HULLER.

in which a special cylinder and set of concaves is used in place of the ordinary threshing cylinder. Such a makeshift, however, is not generally satisfactory. A better arrangement which is adopted by some manufacturers is to introduce another cylinder to do the hulling. A combined machine of this kind built by the Westinghouse Company, which is said to do very good work, is illustrated in figure 70. The lower cylinder, which is of the bradded type, is the huller cylinder.